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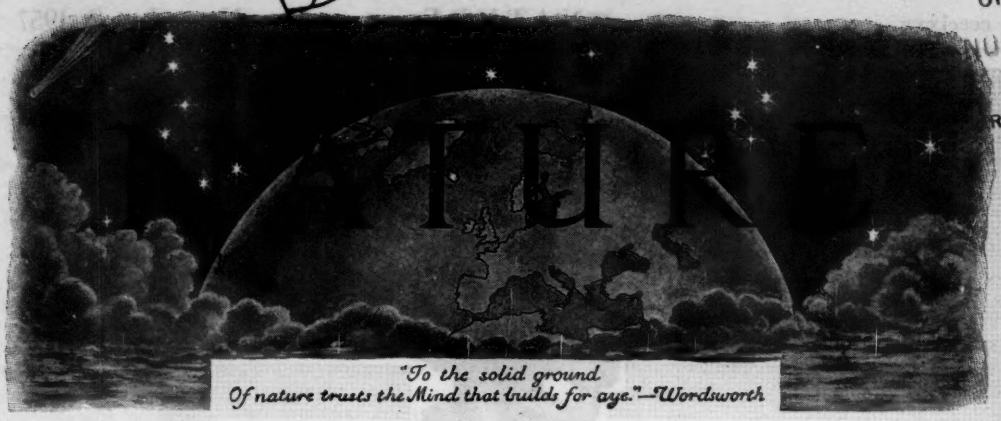


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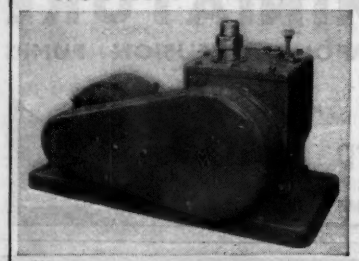

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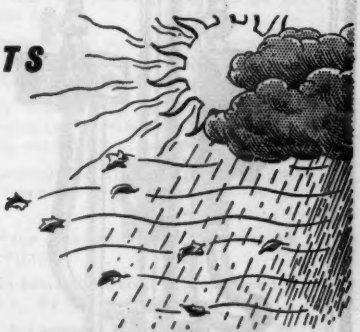

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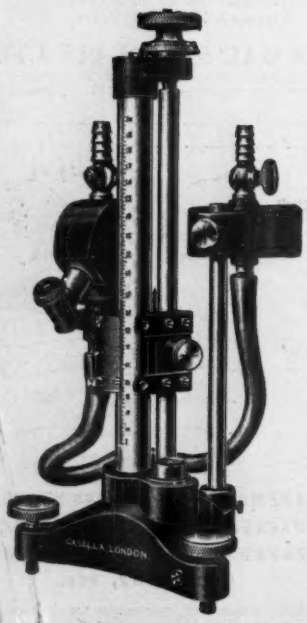

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# NATURE

No. 4592 SATURDAY, NOVEMBER 2, 1957 Vol. 180

## CONTENTS

| | Page |
|---|---|
| Significance of University Training in Industry | 871 |
| Thomist Philosophy. By The Very Rev. W. R. Matthews, K.C.V.O. | 873 |
| The Primates | 874 |
| Electrical Science. By H. Kayser | 875 |
| Numerical Methods. By Dr. A. D. Booth | 875 |
| Commonwealth Industrial Conference. By Dr. W. H. Scott | 876 |
| Model Building for Economists. By Prof. D. G. Champernowne | 876 |
| Pacific Oceanography. By Dr. G. E. R. Deacon, C.B.E., F.R.S. | 877 |
| Radio Observations of the Russian Earth Satellite. By the Staff of the Mullard Radio Astronomy Observatory, Cambridge | 879 |
| Underwater Swimming and Diving. By Dr. H. J. Taylor | 883 |
| The Origins of Life. By N. W. Pirie, F.R.S. | 886 |
| Obituaries : | |
| Sir John Parsons, C.B.E., F.R.S. By A. Harold Levy | 889 |
| Dr. Kathleen M. Drew. By Dr. Mary Calder | 889 |
| News and Views | 890 |
| International Co-operation in Marine Research. By Dr. G. E. R. Deacon, C.B.E., F.R.S. | 894 |
| The Technical Assistance Board | 895 |
| The Nuffield Foundation | 896 |
| The Defence Standards Laboratories, Australia | 898 |
| Geography in Japan. By Dr. L. Dudley Stamp, C.B.E. | 899 |
| Making and Breaking Polymer Molecules. By Dr. L. Bateman | 899 |
| Psychological and Occupational Aspects of Ageing. By Prof. L. S. Hearnshaw | 902 |
| Biogeographical Significance of Aneityum Island, New Hebrides. By Miss L. E. Cheesman, O.B.E. | 903 |
| Interaction between Organic Hydroxy Acids and Silicic and Germanic Acids in Aqueous Solutions. By E. R. Clark and J. A. Waddams | 904 |
| Structure of Smooth Muscles. By Dr. Jean Hanson and Dr. J. Lowy | 906 |
| Letters to the Editors : | |
| Electron Microscope Studies on Colloidal Silver Iodide employing Cinematographic Techniques.—R. W. Horne and Dr. R. H. Ottewill | 910 |
| Nature of the Lunar Surface.—John J. Gilvarry | 911 |
| Internal Flaws in Bonded Cylinders of Soft Vulcanized Rubber subjected to Tensile Loads.—A. N. Gent and P. B. Lindley | 912 |
| Preferential Ionization of Argon in the Presence of Air and its Application to Electric Discharge Devices.—D. P. C. Thackeray | 913 |
| New Crystallite Orientations of Cellulose I in *Spirogyra* Cell-walls.—Dr. D. R. Kreger | 914 |
| Degradation of Biologically Synthesized Lactose labelled with Carbon-14.—Frederick J. Carleton, Henry R. Roberts and Leighton A. Nutting | 915 |
| Kopsine and Strychnine : a Comparative Study of their Physiological Properties.—Dr. S. R. Mukherjee, Ajit Maiti and P. K. Dey | 916 |
| An Antibiotic from Maggots.—E. R. Pavillard and Dr. E. A. Wright | 916 |
| Serum Protein Differences in Cattle by Starch Gel Electrophoresis.—G. C. Ashton | 917 |
| Purification of β-Glucuronidase from Female Rat Preputial Gland. By Dr. G. A. Levvy and C. A. Marsh | 919 |
| Excretion of Yttrium and Lanthanum Chelates of Cyclohexane 1,2-*Trans* Diamine Tetraacetic Acid and Diethylenetriamine Pentaacetic Acid in Man.—Drs. Harry Kroll, Samuel Korman, Elsie Siegel, Hiram E. Hart, Betty Rosoff, Herta Spencer and Daniel Laszlo | 919 |
| Site of Chloride Regulation in Marine Fish Larvæ.—J. E. Shelbourne | 920 |
| Effect of Flavin Monosulphate on Old Yellow Enzyme.—Prof. Hugo Theorell, Kunio Yagi, George D. Ludwig and Fujio Egami | 922 |
| Lack of Growth-promoting Activity of Inactivated Penicillin with Turkey Poults.—J. R. Jowsey, F. D. Cook, H. I. MacGregor and R. M. Blakely | 923 |
| Effect of Different Dietary Fats on the Fæcal End-Products of Cholesterol Metabolism.—H. Gordon, B. Lewis, L. Eales and Prof. J. F. Brock | 923 |
| A New Type of Carcinostatic Agent.—Prof. L. V. Heilbrunn, T. R. Tosteson, E. Davidson and W. L. Wilson | 924 |
| Innervation of the Lamellibranch Muscle.—A. Abrahám and E. Minker | 925 |
| A Lipid Material in Bone and Teeth in Experimental Chronic Fluorosis. By Gertrud Lindemann | 926 |
| Colour Vision of Achromats' Parents.—Prof. R. W. Pickford | 926 |
| Lactic Movements in *Chlamydomonas moewussi*.—Dr. A. M. Mayer and A. Poljakoff-Mayber | 927 |
| Polyhedral Shape of Adenovirus Particles as shown by Electron Microscopy.—Dr. R. C. Valentine and Dr. P. K. Hopper | 928 |
| The Polyhedral Virus of *Heliothis armigera* (Hbn.).—Dr. Kenneth M. Smith, C.B.E., F.R.S., and C. F. Rivers | 928 |

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# SIGNIFICANCE OF UNIVERSITY TRAINING IN INDUSTRY

FOR the past three years Political and Economic Planning has been engaged on an inquiry into the employment of graduates in industry, and this study, which has been sponsored by the Joint Committee on Human Relations of the Department of Scientific and Industrial Research and the Medical Research Council, assisted by a grant under the Conditional Aid Scheme for the Use of Counterpart Funds derived from United States Economic Aid, resulted last autumn in a report entitled "Graduate Employment". In that report, nearly four thousand replies to a questionnaire sent to men who took a first degree in arts, science or technology at a university or through a university college in the academic year 1949–50 were analysed. This sample survey traced the careers of these men for the first few years and threw some light on the factors determining their choice of career. The inquiry, however, also visualized a survey of the views of the universities on the whole question of education for industry, and a third survey, of the views of industry on this question and into the developments that are taking place in industry in the recruitment and employment of university men and women.

A report has now been issued on this third aspect*, which was governed by the following terms of reference approved by the Department of Scientific and Industrial Research, for which the inquiry was made: "To investigate the policy and practice of British industrial undertakings in respect of the recruitment, training and employment of university graduates".

The report is concerned with a sample only of the graduates covered by the first inquiry—some 594 of the graduates and 47 out of the 700 industrial firms, to which four area gas boards, as representing the nationalized industries, were added; and of these graduates, 517 were still in industry when they were interviewed. About a fifth of them went into the chemical and allied industries, and nearly a quarter into electrical engineering: 9 per cent went into firms manufacturing metal or metal goods, and another 9 per cent into firms producing consumer goods in the widest sense. Some 60 per cent of the men were still with the firm about which they were interviewed.

The general impression left by the survey is of the empirical approach made both by employers and by graduates to the whole question of university men in industry; but that nevertheless, on the whole, both managers and graduates were satisfied with the use made of graduates' abilities. Neither the graduates, nor their employers, thought of themselves as a class apart, nor were they so employed. Once a graduate had joined a firm, he was considered primarily as an individual, treated on his merits and had to make his way alongside others who had not gone to a university. At each stage from recruitment onwards, firms tended to adopt such measures as seemed most fitted to their needs and to adjust them in the light of experience, and the results, if informal rather than formal, were none the less deliberate and level-headed. Only at the stage of recruitment did it appear that shortage of supply of qualified manpower was leading to the adoption of measures out of proportion to the results achieved.

It is at this point that the report makes its strongest criticism of existing practice, while emphasizing the extreme importance of an effective partnership between industry and the universities; but it finds a good augury for further advance in the adaptability which has marked industry's relations with the universities since the War. Since the survey was made, the system under which firms send at their own expense acceptable candidates from their staff to universities has developed greatly, but P E P suggests that the possible effects of this policy on recruitment merit consideration. Elsewhere, P E P comments that the form taken by recruitment campaigns should be a matter of much concern, since they affect university teaching staff as well as students. To say the least, the continual invasion of university life by those seeking to recruit scientists and technologists is disturbing, and the universities' new programme of expansion, which will provide more graduate scientists and technologists, will contribute to the long-term solution. In the short term, however, P E P suggests that the larger firms conducting these recruitment campaigns and setting the pace might consider whether there is anything they could do to mitigate their impact on university life.

This is only one aspect of the relations between the universities and industry on which some stress is laid. Forty-three of the undertakings had a deliberate policy of recruiting graduates, and almost all these had some graduate scientists or technologists on their staff and gave as a reason for recruiting them that they needed the knowledge the graduates had acquired. Only half gave as a reason their value as potential managers. Fewer firms recruited arts graduates, and only a third of these recruited them with the possibility in mind of their eventual promotion to management. Again, much emphasis was laid on the importance of personal qualities, especially the ability to get on with, and eventually to lead, others. Sometimes there was aversion to brilliance or a first-class honours degree, and when the desired personal qualities were not found in the graduates eventually recruited, this was occasionally attributed to the lack of residential accommodation at the universities.

*Graduates in Industry. Pp. xxii+261. (London: Political and Economic Planning; and George Allen and Unwin, Ltd., 1957.) 30s.

Broadly, the numbers of university graduates on the strength, the academic standard sought in recruitment and the regularity of the steps taken to assess need, ran with the size of the firm; but it is obvious that this requirement bears closely on the character of the education and the facilities to be provided at the universities. Even if industry takes appropriate steps, as P E P suggests, to ensure that the best-qualified recruits are used to the full extent of their capacities in the initial stages of their careers, and carefully grades the work on which graduates and non-graduates are set, the reconciliation of the conflict between industry's specialized interests in certain fields of knowledge, and the traditional functions of a university as a seat of learning for its own sake and in all its disciplines, is not simple. Although a little more than half the members of management thought that universities should do more to meet the needs of industry, a third thought they could do no more; nor did the views expressed amount to any serious challenge to the policy of the universities. Some members of management stated explicitly, and more implied, that it was for the universities and not for industry to set the pace.

Nevertheless, even if the influence is indirect rather than direct, the steadily rising proportion of university students in receipt of assistance from public funds in one way or other means that the universities must be increasingly concerned to supply graduates with the qualities sought by their prospective employers; nor can we assume that the balance of studies is unchangeable. It should be noted that, while half the members of management believed that a university education had advantages for industry over a technical college education, a large proportion were non-committal. There was, however, a great measure of acceptance of the principle that the universities should not be asked to cater in first-degree courses for the specialized interests of particular industries, and some indication of a trend of opinion in favour of making the established first-degree courses in science and technology more fundamental, reserving any specialization for post-university courses, and of leaving to industry itself the responsibility for seeing that the knowledge acquired at the university is fruitfully applied.

The views were subject to reservations as to the need for closer contacts with industry by university teaching staff and for the acquisition of greater knowledge of industry by undergraduates heading for it; and vacation work was largely favoured for this purpose. There is a substantial body of university opinion against vacation work as such, and P E P suggests that an inquiry concerned primarily with vacation work as a means of preparing undergraduates for a career in industry might be well worth while. There was little evidence of support from the management side for the sandwich system so far as the universities are concerned, and the academic year in Britain does not lend itself very readily to this system.

The further provision made for the study of industrial management at certain universities since the time of the survey meets to some extent the call for such courses made from the management side. Although there are indications that university teaching staff are inclining to the view that a management discipline, if evolved, would not be incompatible with the true function of a university, even when the survey was made the general consensus of opinion appeared to be that the greater part, at least, of such study should be reserved for the post-university stage, when the student is more mature and freer to concentrate on it. Since then, the trend of thought has been in favour of reserving the subject until the graduate has had enough industrial experience to profit by study of it—until he is at least about twenty-seven years old. The stress which has been laid upon efficiency in management by the developments loosely described as automation and the emphasis given to human relations in industry all point in the same direction.

An important aspect of the expansion of technological education on which the survey throws some light is the proportion of men with academic qualifications beyond the first degree who are needed. Admittedly, the value of a higher degree to a firm must depend largely on the standard and the level of scientific and technological work undertaken, and not only in research departments; but nevertheless, it is noteworthy that only a third of the members of management questioned saw any value in a higher degree and few of these were emphatic. Political and Economic Planning thinks it possible that the new arrangements for centralizing in the Department of Scientific and Industrial Research awards of research studentships in science and technology may eventually meet some of the criticisms made of the usefulness of higher degrees. In particular, the new advanced course studentship awards in "a specialized subject, a training in which is expected to add substantially to the value of the degree already taken", will meet the wish expressed by some managements for graduates to receive specialized training in the branch of science or technology in which the firm was interested, after a broad first-degree course.

Apart from these questions of shortage of supply, the picture presented by the survey shows a substantial measure of agreement with the new partnership with the universities. While there was some indication of greater readiness on the part of industry to accept responsibility for seeing that the knowledge acquired at the university by its recruits is fruitfully applied, there is plenty of evidence that with closer co-operation and increase in mutual understanding many useful suggestions will come from industry as to the content of courses, and especially in regard to the form and phasing of post-university study and the proportions in which men—and women—of any given standard are required. P E P wisely points out that increasing attention must be given to the whole question of the proportion of each grade needed in any particular circumstances, from

the lowest qualified technician to the most highly qualified technologist.

This question is basic to the planning of the expansion of technical and technological education in Great Britain; but it has so far been virtually ignored. Unless that expansion is planned in relation to ascertained needs, we cannot well avoid waste of the large sums of money now committed, and it is essential that there should be no interruptions to the building programmes at present authorized for the colleges of technology, technical colleges or the universities, except in accordance with definitely determined needs. In its default, we are likely to see once again expansion postponed for short-sighted and illusory reasons of economy.

Nor is this the only point at which the survey touches on the question of husbanding our resources. Selection techniques are only in their infancy, and while selection was generally in the hands of people with wide experience of selection or with direct knowledge of the field in which the candidate might be going to work, more efficient selection could obviously help to reduce the loss from industry to other walks of life of an eighth of the men it recruited from the 1950 graduation year. A certain amount of mobility between jobs is desirable as the best means of widening experience, and in some fields such as research could stimulate creative work. Nevertheless, the actual turnover appears to be higher than is really necessary, and while, on one hand, it is related to the accuracy with which a firm assesses its needs for graduates, on the other it depends both on the skill with which selection is made and the treatment, including training, which the recruit receives.

In regard to the first, the survey emphasizes the importance of industry continually re-examining and assessing what kinds of graduates it really wants, and in what numbers, especially in view of changes hoped for in the proportion of students reading for an arts degree or for a science degree, and of the major developments in train for the expansion of technological education. Industry claimed 30 per cent of those graduating in 1950, and it is unlikely that, except possibly in university teaching, the demand for graduates from other quarters will increase proportionately as much as that of industry. P E P points out very firmly that improved methods of selection, the better matching of men to work and the more efficient grading of work and assessment of performance in it all contribute to sharper definition of industry's demands on the universities, while qualitatively industry should be thinking out the implications of the argument that the non-scientist and the scientist, in whatever walk of life, must be enabled to appreciate each other's methods and approaches, and formulating proposals for measures which the universities might take to that end.

In regard to the second, it is suggested that problems encountered in introducing graduate recruits to a firm and in training them might be overcome if some well-chosen senior member of the staff established and maintained a close and friendly relation with each new entrant. Employers might be able to judge more accurately the real calibre of the newcomer and become more quickly aware of any frustrations and misunderstandings. They might also be better able to reduce the rather high rate of dissatisfaction with prospects of pay and promotion, which was closely related to the turnover, in itself a source of waste of man-power. It also seems reasonable to expect that, as P E P remarks, the appointment of a senior to establish and maintain a close relation with arts graduate recruits might also contribute towards further developments in the ways in which they might be employed, and generally in making the initial period in the firm more rewarding or at least more explicable. Further, the survey notes that arts graduates were the least satisfied with their first job, and science graduates the most satisfied; and it would appear probable that such a senior appointment could well help to probe the genuineness of dissatisfaction, to remove it where genuine, either by dissipating misunderstanding or by representing to the management a point of view that policy had overlooked or ignored. Incidentally, if the volume of unjustified dissatisfaction or disgruntlement proved to be large or excessive, some clues might be obtained which the universities could follow with the view of modifying their courses. Both industry and the universities should be helped by this survey, which, while once again pointing to the need and value of further continuous study in this field, emphasizes the importance and urgency of various developments now in train, and indicates directions in which further inquiry and some strenuous thinking are imperative by industry, by the universities and by the Government.

## THOMIST PHILOSOPHY

**The Christian Philosophy of St. Thomas Aquinas** By Etienne Gilson. With a catalogue of St. Thomas's Works by I. T. Eschmann, *O.P.* Translated by L. K. Shook, *C.S.B.* Pp. x+502. (London: Victor Gollancz, Ltd., 1957.) 42*s.* net.

ETIENNE GILSON'S massive study of the philosophy of Thomas Aquinas is now available in English and we are indebted to his translator for a faithful and reasonably clear version of this important work. No translation which was accurate could make it easy reading, and probably only those who share M. Gilson's conviction that Thomism is a system of thought in its main outlines valid to-day will have the determination to persevere to the end. Gilson himself has no doubt on this matter. He holds that "the basic metaphysical positions of Thomas Aquinas are still far ahead of what is considered most progressive in the philosophical thought of our own times". He claims that Thomism is not only an interesting phase in the history of philosophy, but also a "live option" for contemporary reflexion. "I do not say of Thomas that he was right, but that he *is* right."

Gilson has organized his material in three sections: 'God', 'Nature' and 'Morality', a plan which enables the reader to gain a comprehensive view of the system and to recognize the astonishing range and the coherent structure of St. Thomas's thought. The value of the book is enhanced by the full notes and references provided by the author and by the catalogue of St. Thomas's writings contributed by I. T. Eschmann. It is possible in a short review to comment only on a few points of interest in this extensive study. Anyone unacquainted with the vast literature of interpretation which has grown up may be surprised to learn that there are fundamental differences among experts about the proper approach to the Thomist philosophy. Gilson's view may be described as, in a sense, 'existentialist'. In his opinion, the conception of 'act of being' is central for any true understanding of the philosophy and he deplores the prevalence of an 'essentialist' interpretation in the Roman Catholic Church. The layman may have some difficulty in grasping the significance of this distinction, but the effort is worth making, because the matter in dispute really does go to the root of the question of what Thomas conceives reality to be.

The chapter on the famous 'Five Ways' by which the intellect moves towards the affirmation 'God exists' will no doubt attract the attention of most readers and it is among the best in the book. Gilson brings out the logical character of the proofs with admirable clarity. "All the Thomistic proofs for the existence of God amount, in the last analysis, to a search, beyond existences which are not self-sufficient, for an existence which is self-sufficient and which, because it is so, can be the first cause of all others." Excellently put—but we are not told how a 'search' becomes a 'proof'. It is worth while, perhaps, noting that Gilson, following Thomas, quotes as a guiding principle the famous phrase in Exodus, "I am that I am", and takes it to indicate eternal and immutable being. Surely it is time that some interpreter of Thomism should deal with the objection that the Hebrew probably means, "I will be what I will be"—a sentence which suggests a very different idea. Of course, this has no relevance to the validity of Thomas's metaphysics as such, but it does have some bearing on the question whether his doctrine of God is, as is asserted, the crown of a definitely Christian philosophy. Gilson's book is a fine example of patient scholarship and thinking and, moreover, a worthy tribute to a great philosopher.

W. R. Matthews

## THE PRIMATES

**Primates**

Comparative Anatomy and Taxonomy. By W. C. Osman Hill. 3: Pithecoidea. Platyrrhini (Families Hapalidae and Callimiconidae). Pp. xix+354+27 plates. (Edinburgh: At the University Press, 1957. Distributed by Thomas Nelson and Sons, Ltd.) 90*s*. net.

In the third of his monographs on the primates, Dr. W. C. Osman Hill continues his labour of drawing together what is known about the comparative anatomy and taxonomy of the mammalian order to which man belongs. The present volume deals with the family Hapalidae (= Callithricidae) of the New World monkeys, and follows the pattern of the two by which it was preceded, the merits and shortcomings of which it also shares. Dr. Hill's aim, which is to provide an authoritative and up-to-date account of the marmosets and tamarins, is an ambitious one, and he deserves great praise for giving us once again a book which students of the subject will find both convenient and wise to consult. Presumably because encyclopædic works have a habit of not being written, or if started, not being finished, Dr. Hill has made the completion of his task a goal in its own right. But haste has taken an inevitable toll in scholarship and detachment.

According to Gaylord Simpson's classification, the New World monkeys comprise the superfamily Ceboidea, consisting of the family Cebidae, itself broken down into a number of sub-families, and the family Callithricidae, with the latter of which Dr. Hill is concerned in the present volume. Dr. Hill gives no sound reason for departing from the taxonomic rules, the existence of which he acknowledges, when he refers to the Callithricidae as the Hapalidae. The title page and text also refer to, and deal with, a so-called family Callimiconidae. This family consists of the one genus *Callimico*, with a single species constituted by a small tamarin-like creature from the Upper Amazon. It seems that this species is known from no more than perhaps a dozen specimens that have lived in zoos.

The late Oldfield Thomas, of the British Museum, regarded *Callimico* as a taxonomic sub-family of the Cebidae, because of the correspondence of its dental formula to that of the capuchin monkeys—a view that is now endorsed by Gaylord Simpson. A little later Pocock took the line that the tamarin-like feet and hands of *Callimico* argued that the creature should be designated as a sub-family of the Hapalidae (= Callithricidae). Then Dollman "took the bolder step of raising *Callimico* to the rank of a distinct Family intermediate between the Hapalidae and Cebidae". It is this bolder step which Dr. Hill, again without giving any reasons for his preference, follows.

In the preface, however, Dr. Hill apologizes for doing this. Too late to allow of any alterations in his title-page or text, an opportunity was provided him for studying a specimen of *Callimico*. As a result of this increase in his knowledge, he decided that *Callimico* does not represent a family of its own, but really belongs to the tamarins.

There is, perhaps, something almost too arbitrary in this treatment of familial distinctions in primate taxonomy. The prominence of the slip inevitably draws one's attention to the apparently casual way in which Dr. Hill treats different schemes of classification; and to the difficulty of deciding which parts of his descriptions are derived from which sources.

Unfortunately there are other places where he has not exercised his critical faculty to the full. He states, for example, that "in a broad way . . . there is an ascending grade of complexity in behavioural mechanisms from the marmosets up through monkeys and anthropoid apes to the human level"—when such evidence as there is points to little or no gradation in definable behavioural characteristics as between monkeys as a group and apes as a group. He tells us that "vocalization" in many instances deserves the name of "veritable language", but the name of the one 'authority' he cites does not leave the reader with the confident feeling that Dr. Hill has consulted any serious studies on the subject of language. He writes that "menstruation has not been shown to

occur in any platyrrhine", which is contrary to fact; and to give another example, he talks of "lethal factors" in a genetic content, in a way which suggests that he does not realize how much biometrical study needs to be undertaken before such things can be posited.

But having said all this, the fact remains that, in spite of these faults, the book contains a mass of good meat. Its very presence and massiveness will ensure it, as the same qualities will their predecessors, a useful life.

## ELECTRICAL SCIENCE

### Introduction to Electrical Applied Physics

By Prof. N. F. Astbury. Pp. xi+241. (London: Chapman and Hall, Ltd., 1956.) 36*s*. net.

AS the author says in the preface to his book, it is an attempt to bring together the classical bases of electrical science and the elements of some specialist topics which, by the natural processes of technological evolution, are finding their way into all fields of applied science.

The method of presentation used throughout the book is to deal first with the fundamental physical and theoretical principles of each topic and then to apply them to the consideration of practical problems. Special mathematical tools such as space vectors, Bessel functions and Heaviside's operational analysis are treated with their applications, rather than abstractly and in a separate part of the book. This feature will be particularly welcomed by the reader with a practical rather than an analytical turn of mind. Consequently, each chapter is almost self-contained and the necessity for cross-referencing is much reduced. But where it is still needed, the task might have been simplified by the simple expedient of marking the chapter and section numbers on each page.

The book begins with a consideration of the physical basis of the subject, introducing the concepts of the quantum theory when dealing with electric conduction in solids, treating the origin of magnetism from the point of view of the domain theory, and briefly outlining the behaviour of dielectrics in terms of polar and non-polar molecules. Electric and magnetic fields are treated on classical lines. In a chapter on electrical units and the general field equations, a sound case is made for using a rational system of units which gives the general equations a homogeneous form; the rationalized M.K.S. system is used throughout the book. An examination of the field equations when conduction current is present leads to expressions for the penetration of flux, and for the eddy-current loss, in flat sheets and circular cylinders, and for the skin effect in cylindrical conductors; Bessel functions are introduced to the reader unfamiliar with them as the solutions to familiar problems.

The chapter on electric circuits deals with lines, filters and general methods of circuit analysis including the use of the Laplace transform. (The use of the lower case symbol $i$ for the electric current vector in equations such as $V/i = R + jX$ should be altered in a reprint of the book.)

Gapped magnetic circuits, including permanent magnets, the equivalent circuit of an iron-cored coil system, distortion and the magnetic amplifier, are treated in an excellent chapter on magnetic circuits. As in other parts of the book, the author has succeeded in presenting the basic physical facts and principles so that they seem to lead naturally to important practical applications.

In connexion with electro-mechanical and electro-acoustical systems, limitations of sensitivity due to noise are considered, and a brief introduction is given to the study of servo-mechanisms. The chapter on electron devices deals with the deflexion of electron beams, thermionic valves and valve amplifiers, transistors and photosensitive devices. The final chapter deals with electro-magnetic waves and radiation, including a study of transmission through the ionosphere and an introduction to the theory of wave guides.

As the author modestly observes in the preface, "the subject of every chapter in this book forms, elsewhere, the subject of a separate treatise", and those recommended by the author are listed in the book. Unfortunately, no other references are given.

The work is intended for the senior university student in physics or engineering, but it should also appeal to others seeking an understanding of the principles underlying many recent technological developments. It is easy to read, well produced and reasonably priced.

H. KAYSER

## NUMERICAL METHODS

### Numerical Methods

By Dr. R. A. Buckingham. Pp. xii+597. (London: Sir Isaac Pitman and Sons, Ltd., 1957.) 70*s*. net.

IN recent years a number of books on numerical analysis have been brought before the scientific public, and these vary in their objectives from educational didactics to automatic digital calculators, and in their style from lucidity to the pomposity which besets certain authors when they come to expound their so-called 'philosophy'. Dr. R. A. Buckingham's book is the latest work on the subject to come before the reviewer and, although the publishers' lists seem to give promise of more such works in the future, it will be difficult for authors to find new ground to cover, at least on the general plane.

To the last statement certain limited qualifications are necessary. Two omissions from his book are mentioned by Dr. R. A. Buckingham in his preface: namely, discussion of Gaussian methods of quadrature and of the Runge–Kutta formulæ for the solution of differential equations. It is a little difficult to accept the author's excuse that these omissions are justified by the presence of an adequate literature in the field, because this applies to much that he does include. A further omission, which is rather more difficult to understand, is that of an up-to-date discussion of throwback, particularly in view of the author's plea that the book is intended for hand computers. On a minor plane, I regret the absence of an account of vector-space methods for the solution of simultaneous equations, linear and otherwise.

These criticisms are, however, ones of detail and should not detract from the overall good impression which the contents of the book produce. The treatment is to some extent classical. Thus, the first five chapters discuss errors, tables and desk machines;

the various forms of differences; Lagrangian interpolation, differentiation and integration; and Newtonian divided differences and their consequences respectively: curiously, operational methods are relegated to Chapter 6 as though by afterthought.

The next two chapters contain a good summary of the methods which can be used to solve one-point boundary-value ordinary differential equations, and these are followed by Chapter 9 on polynomial equations and Chapter 10 on curve fitting by the methods of least squares. Simultaneous linear equations, matrices and the relaxation method then receive a chapter each, and these lead to Chapter 14 on two-point boundary-value problems, latent roots, and integral equations. Finally, there are two chapters, on two-dimensional interpolation and on partial differential equations respectively, and the book ends with four appendixes containing formulæ.

The book is lavishly provided with worked examples which will be useful to student and teacher alike, and the only place where detail is, perhaps, insufficient is in the section on the relaxation method. Only the high price will prevent the book from adorning the shelves of all serious numerical analysts, and this must be weighed against its considerable size. I end on a note of criticism of the publishers: the format is (to quote a colleague) "execrable" and the narrow margins surely cannot be justified on any grounds of paper economy at the present time.

A. D. Booth

## COMMONWEALTH INDUSTRIAL CONFERENCE

### His Royal Highness the Duke of Edinburgh's Study Conference on the Human Problems of Industrial Communities Within the Commonwealth and Empire, Oxford, 9–27 July, 1956

Vol. 1: Report and Proceedings. Pp. xii+338+7 plates. Vol. 2: Background Papers; Appendixes; and Index. Pp. xv+339. (London and New York: Oxford University Press, 1957.) 42*s*. net the set of two volumes.

THESE two volumes constitute a complete record of the proceedings of the Conference (see *Nature*, 178, 341; 1956). Their principal contents are the addresses given at the Conference, the reports of the study groups into which the Conference membership was divided, each of which spent a week studying particular problems in one of the main industrial areas of Britain, and the background papers which were distributed to members to stimulate thought on some of the more important issues.

The background papers are, from a reader's point of view, the most valuable element. They provide a fairly comprehensive and often stimulating introduction to the problems of particular territories, ranging from Australasia through Malaya, India, East and West Africa to Britain itself; the remaining nine are more general and include contributions on political life (by Sir Ivor Jennings), the will to work (Prof. C. A. Mace), and values in an industrial society (Prof. D. W. Harding). The sixteen addresses given at the Conference, mainly by industrialists and trade unionists, are of a fairly general nature, and cover such topics as industrial structure, developments in management, work motivations, industry and the community, and the multi-racial society. They are useful, but do not always reach the high standard set by many of the background papers.

Considered as a contribution to knowledge, the two volumes provide little that is new to the professional social scientist, nor perhaps is this to be expected in a conference concerned primarily with practical problems. It is, however, legitimate to ask whether existing knowledge has been brought to bear to the fullest extent. Prince Philip, in his presidential address, urged the participants to take into account the "great amount of work already done", and Sir John Maud in his address particularly mentioned the indispensable contribution of the social scientist. Despite these exhortations, it is difficult to avoid the conclusion that the organizers were not particularly successful in making this contribution available to the Conference. So far as one can see, not a single professional social scientist addressed the Conference, although a number of background papers were contributed by sociologists. It would not be difficult to list several recent researches, and in particular those sponsored by the Joint Department of Scientific and Industrial Research and Medical Research Council Committee on Human Relations, which are directly relevant to the problems discussed but which were apparently passed over.

What impact will the Conference have made? Prince Philip was again realistic when he commented that it could only scratch the surface, and Sir Philip Morris in his summing up urged the members to recognize that study in a conference is necessarily practical and superficial, and that its full fruit could be ripened only by continual effort. Will it so ripen? It is difficult to avoid pessimism. Conferences all too frequently have a stimulating but transient effect on busy practitioners. Experience suggests that rapid progress in any field demands two conditions—the systematic study of problems, and an effective link between students and practitioners. The Conference fruits will ripen only if social research into industrial problems is steadily extended, and if practitioners have regular opportunities to study developing knowledge and ideas. Indeed, the best sequel to the Conference would be an extension of present arrangements for practitioners both in Britain and overseas to spend, preferably in small groups, a period of study leave at one or other of the few universities in Britain which are so far equipped to receive them.

W. H. Scott

## MODEL BUILDING FOR ECONOMISTS

### Mathematical Economics

By Prof. R. G. D. Allen. Pp. xvi+768. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1956.) 63*s*. net.

ECONOMISTS, in their interpretation of the present, mainly rely on the historical approach and on reasoning by analogy with the past; but this frequently involves considering the interplay of several influences. As a means of avoiding false reasoning and of simplifying and shortening logical arguments, economists have made increasing use of the abstract 'model'. This model represents the real situation in an ideal State, with most of the com-

plications assumed to be absent, so that attention can be focused on the interplay of what are supposed to be the most important influences. The models obey exact mathematical laws and the art of building them requires some mathematical expertise. Many economists know enough of one branch of mathematics to build some imposing models: few know enough to understand the models built by the others. Prof. R. G. D. Allen's book should help to spread the mutual understanding.

Mathematical economics or model-building is, however, still mainly the subject either of specialist periodicals devoted to it as to a hobby such as chess, or, more usefully, of appendixes and footnotes in more serious works which really are about economics. It here serves to clear up knotty logical points, cropping up in the course of discussing practical questions, in terms of political arithmetic and history. Unless he remembers this subsidiary part played by mathematical economics in economics proper, any reader coming fresh to this book from a study of mathematics or science will be in danger of forming a very distorted impression of what economics is about.

This book confines itself to a limited but representative selection of types of economic model, each of which has been created in response to the genuine needs and interests of *bona fide* economists. The author shows how the same few basic mathematical techniques appear over and over again in widely different fields of application: and he provides a series of lucid mathematical chapters, giving the basic training in these selected mathematical techniques. Their level is sufficiently advanced for it to be doubtful whether, apart from Prof. Allen himself, any reputable English economist could claim that he had already mastered much more than half of them. The mathematical chapters in this book are written in a style very well suited to the requirements of those who would care to master more.

By denying himself any treatment of questions relating to probability or random variates, the author allows himself a fuller treatment of other topics. He gives considerable emphasis to the application of linear differential equations and difference equations to the study of models reproducing trade-cycle phenomena. Such methods are useful only to models yielding oscillatory movements in the variables concerned: they are usually inadequate to analyse models which yield two alternating positions of temporary stable equilibrium, boom and slump: accordingly such non-linear models are given only very brief mention: yet it may be that they are of more relevance to the world we live in. This suggests one unavoidable handicap imposed by the method of selection of subject-matter according to its mathematical content: namely, that the more mathematically awkward subjects tend to be omitted.

Linear programming and von Neumann's theory of two-person games receive liberal attention: these are of relevance in situations where one knows exactly what one wants and how much, and the extent of the resources that are available for obtaining it. This is the branch of economics devoted to war and siege, but it also has applications to the operations of the very large business unit and of planning committees. The calculation of optimum programmes is in practice very tedious, but the increasing availability of electronic calculators will reduce the importance of this consideration.

Vector and matrix algebra also receive full treatment. These, for example, enable the economist to extend his arguments from the representative man consuming *the* consumption-good produced by industry, to deal with families of varying composition and income consuming a series of consumption-goods and services provided by a list of industries and caterers.

This book should be compulsory reading for all economists seeking to publish articles involving economic models. D. G. CHAMPERNOWNE

## PACIFIC OCEANOGRAPHY

### Oceanic Observations of the Pacific, 1949

Edited by N. W. Rakestraw, Paul L. Horrer and Warren S. Wooster. Pp. 363. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1957.) 34*s*. net.

THE usefulness of oceanographical data is increased by early publication, but getting them prepared for publication is not easy. The purpose of the observations is often exciting and rewarding, and everyone gets on with it, and probably uses only a selection of the data. The task of checking thermometer corrections, salinity figures, density calculations, and other computations for all the data, for other uses and for others to use, is an urgent duty which is often neglected owing to the claims of direct interpretation and the need of making more observations; there are also the costs of publication and distribution.

The Scripps Institution of Oceanography of the University of California has done marine science a good service by making provision for regular publication of physical and chemical data from the Pacific Ocean. The first volume collects observations made by the Scripps Institution, the Department of Oceanography of the University of Washington, the U.S. Navy Electronics Laboratory and the Pacific Oceanic Fishery Investigations of the U.S. Fish and Wildlife Service, and offers to publish the data of other agencies which work in the Pacific Ocean. It is a handsome well-bound photoprinted book. The first of a series, it contains observations made in 1949 hitherto unpublished, together with charts showing when they were made and a list of published papers referring to the 1949 cruises and to results already obtained from them. The observations cover the ocean north of the equator as far west as Hawaii, and there are closely spaced, repeated, measurements extending four hundred miles off shore between 46° and 25° N. There are not many observations from depths greater than 1,200 m. The remainder of the ocean, and some of the Indian Ocean, and covered by bathythermograph observations, and there are so many thousands that it is not practical to publish them either as photographs or in lists. The numbers available in each 5-degree square are shown in the charts, and copies of the slides are deposited at the Scripps Institution.

Subsequent volumes containing observations made in each succeeding year will be published as soon as they are ready, and there will also be one for observations made prior to 1949 together with a bibliography of earlier sources.

The editorial board at the Scripps Institution, its consultants in the agencies participating in the scheme, and the publishers are to be congratulated on a fine achievement. G. E. R. DEACON

## Outline of Glossematics

A Study in the Methodology of the Humanities with Special Reference to Linguistics. Part 1: General Theory. By H. J. Uldall. (Travaux du Cercle Linguistique de Copenhague, Vol. 10 (1).) Pp. vi+90. (Copenhague: Nordisk Sprog- og Kulturforlag, 1957.) n.p.

THE subject of this book is not, as the title might lead one to suppose, a branch of linguistics; the author is inaugurating a new science, glossematic algebra, which shall be a formal non-quantitative technique of description in 'humanistic' disciplines such as linguistics and history. Pages 1–35 are occupied by general remarks on scientific method, like these: "the pragmatical scientists, never having found anything in a pure state of being, refuse to have anything to do with it" (p. 9); "Any post may bring the scientist news that . . . nothing, or very little, remains of the truths of yesterday" (p. 13). In the formal development of glossematic algebra that follows, the author begins by defining 'function' as "any dependence" and 'functive' as "anything that enters into a function"; the discussion (pp. 36–41) is made hard to follow by the use of a single symbol φ (without subscripts) even in symbolizing situations that involve several functions. He next introduces a specific function, 'connexion' ('both–and'), which is commutative and associative; non-commutative algebras, we learn, are "extremely difficult" to design, and so devices for symbolizing the difference between the words 'fist' and 'fits' are postponed to the next instalment of this work. The next important concept is 'glossematic negation'; the author wishes to show symbolically that, for example, the phoneme which might, but does not, precede the [l] of "lay" is [p], rather than [s] or [k]. The rest of this fascicule is an elaborate set of formal schemata for descriptions, in terms of connexion and negation; some concrete examples are supplied, but these do not carry conviction that glossematic algebra is likely to be a fruitful study.

P. T. Geach

## Lecture Experiments in Chemistry

By G. Fowles. Fourth, revised edition. Pp. xvi+629. (London: G. Bell and Sons, Ltd., 1957.) 42*s*. net.

THE author has added a number of new and interesting experiments to the fourth edition of this book. Thus, on the movement of molecules, the different rates at which hydrogen chloride and ammonia diffuse is illustrated by Prof. Watt's experiment of placing cotton-wool swabs, soaked in hydrochloric acid and aqueous ammonia respectively, at either end of a long tube, and noting the position at which a white ring first forms inside the tube. Similarly, the Brownian movement is demonstrated by a novel experiment using colloidal graphite. The major change in this edition is the recasting of Chapter 6 on physical principles, and the insertion of three new chapters on, respectively, surface chemistry, catalysis and combustion. The intensive study of colloids and adsorption, and their industrial applications, have introduced new processes and products into daily life, and this has enabled the author to describe a number of new experiments. Thus six pages are devoted to the use of ion-exchange resins, and the teacher will find the experiments with coloured ions of particular interest. In view of the size and scope of the book it is, however, a little disappointing to find only one experiment on paper chromatography. Small additions have been made to the appendixes and supplement at the end of the book; these include a short account of recent views on the teaching of chemistry, a few experiments, and further notes on some of the experiments previously described. Like its predecessors, this edition is a mine of useful information, and the revision has been well done apart from a few minor details, such as the descriptions of the mechanisms of the electrolysis of brine (p. 432) and the ferric sulphocyanide reaction (p. 413). The book is well produced and deserves the warm welcome which the other editions have received.

A. C. Cavell

## A Text Book of Theoretical and Inorganic Chemistry

By F. A. Philbrick and Dr. E. J. Holmyard. New revised edition by Dr. E. J. Holmyard and Dr. W. G. Palmer. Pp. ix+845. (London: J. M. Dent and Sons, Ltd., 1956.) 18*s*. 6*d*.

WHEN Dr. Palmer, of the University of Cambridge, was called in as collaborator to help with the production of the 1949 edition of this book, he revised the whole physical chemistry section forming Part 2. He also re-wrote the section on valency, making of it a first-class self-contained article. In preparing the present edition, for which he alone is responsible, Dr. Palmer has thoroughly overhauled the descriptive matter forming Part 3. He has replaced discarded explanations by modern ones; described new reagents, such as lithium aluminium hydride, thereby introducing better methods of preparing diborane and silane; described the use of deuterium and radioactive tracers in the elucidation of molecular structures; here and there deleted or added a few lines, occasionally recasting whole paragraphs. All the changes have been made so skilfully that the pagination is unchanged. There are few text-books of intermediate level combining in one volume both general and descriptive chemistry. Many will be pleased that one of the best of the few has once more been brought up to date.

G. Fowles

## The World of Learning, 1957

Eighth edition. Pp. xxxii+1038. (London: Europa Publications, Ltd., 1957.) 120*s*. net.

"THERE is little room for ornament or artifice in a work of reference. It relies for its effect on the austere beauty of facts." Thus claim the editors of this book. It is doubtful whether there is another volume with so much austere beauty between its covers. "The World of Learning", which has run to eight editions in ten years, lists the academies, learned societies, museums, universities, art galleries and libraries of the whole world, together with their professors, members, curators, presidents and secretaries. One can look up the number of books in the library of the Université d'Haiti or the date of foundation of the West African Cocoa Research Institute. There are a list of publications issued by each institution and a big section on Unesco. Unfortunately, owing to its size, this book omits an index of names—it is possible to look under the University of *X* and find Dr. *Y. Z.* works there, but not to look up Dr. *Y. Z.* in order to find where he does work. Nevertheless, there are few other books with so much readily available, useful and up-to-date information about the world of learning.

# RADIO OBSERVATIONS OF THE RUSSIAN EARTH SATELLITE

By THE STAFF OF THE MULLARD RADIO ASTRONOMY OBSERVATORY, CAMBRIDGE

## History

WHEN the news of the launching of the first Earth satellite was received early on October 5 it was realized that accurate optical or radar observations would be extremely difficult unless reasonably accurate local predictions of the track could be obtained from observations of the radio transmissions from the satellite. No plans for such radio observations were known to us, and we therefore decided to modify an existing radio telescope normally used for the study of radio stars on a frequency of 38 Mc./s.

The first recordings were obtained on the night of October 5–6, and on the following day an improved interferometric aerial system was installed so that the transits of the satellite across the Cambridge meridian could be timed more accurately. A second receiver was also installed to measure the Doppler frequency change. Both instruments were tuned to the 40 Mc./s. transmission to reduce errors caused by ionospheric effects. Similar measurements were afterwards made on the 20 Mc./s. transmissions because a detailed study of these effects seemed likely to be of great value in determining the structure of the ionosphere. Some observations were also made at 80 Mc./s. using the second harmonic of the satellite transmission, to reduce ionospheric effects still further.

With this apparatus we have recorded nightly since October 6 the six to seven transits of the satellite which are observable from the latitude of Cambridge; for each of these transits the track was found, and an approximate orbit of the satellite has been computed. Some new methods of ionospheric investigation have been developed and preliminary results obtained.

## The Observational Methods

(*a*) *The Interferometer.* Two aerials were set up on an accurately surveyed east–west line with a spacing of 4λ, and were used with a phase-switching receiver. The choice of spacing was a compromise between the requirements of angular accuracy and the difficulty of establishing the correct lobe identification. The aerials were simple full-wave dipoles mounted at a height of λ/2, so that all tracks passing within the visible horizon would be observed.

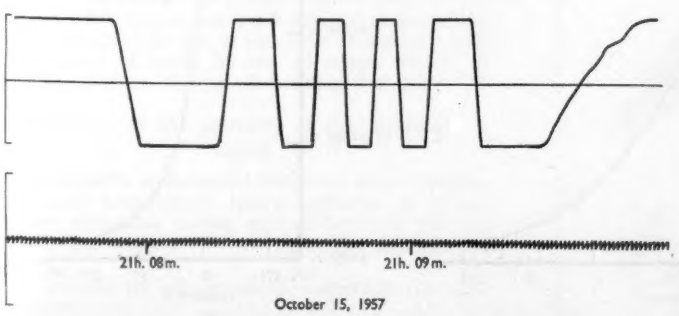



Fig. 1. Record of transit of the satellite observed on the interferometer

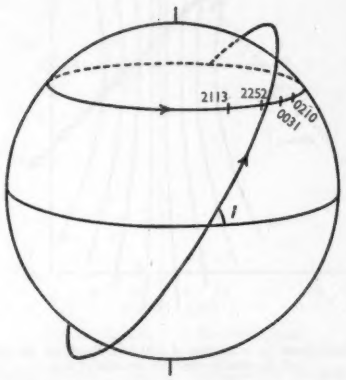



Fig. 2. Diagram showing the orbit in relation to the latitude of Cambridge. The times indicate the approximate position of Cambridge during the successive transits

The interference pattern produced by this system intersects any horizontal plane in a system of hyperbolæ, the form of which will depend upon the height of the plane. The passage of the satellite across these grid lines is obtained from the records as in Fig. 1, from the times at which the trace crosses the central zero.

During the middle of the night, the satellite passes far to the north of Cambridge (Fig. 2).

The linear distance of these tracks may be found by observing the rate of transit across successive grid lines and assuming initially the velocity appropriate to a circular orbit.

This observation provided a measure of the most northerly latitude of the track and thus allowed a preliminary value of the inclination (*i*) of the orbit to be derived.

From this inclination the angle at which the track crossed the latitude of Cambridge could be calculated and it was then possible to use the observed times of crossing the grid lines, in the manner shown in Fig. 3, to select a unique track and height.

For the more distant tracks it is necessary to take account of the Earth's curvature, and when a preliminary elliptical orbit had been derived, the variation of the velocity was also included.

(*b*) *The Doppler Method.* In the second method the apparent frequency of the 40 Mc./s. transmission was recorded during each transit, by mixing the received signal with that from a local 40 Mc./s. oscillator, and measur-

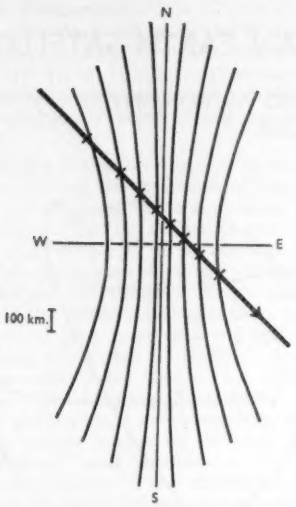



Fig. 3. Grid lines for a height of 530 km. showing the derivation of the track relative to Cambridge

ing the beat note of approximately 6 kc./s.; the latter measurement was done by comparison with a variable audio-frequency oscillator using ear and cathode-ray tube presentation. The readings of the frequency were recorded at intervals of about 3 sec.

The maximum rate of change of the received signal occurs at the time of closest approach of the satellite and is given by $fv^2/cr$, where $f$ is the transmitted frequency, $v$ the satellite velocity and $r$ the distance of the observer from the track. In practice small corrections must be applied to allow for the curvature of the track and the effect of the ionosphere. The 'slant range' to the track could usually be measured with an accuracy of about 5 per cent, and the time at which the satellite was closest to about 5 sec.

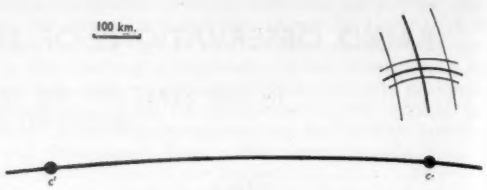



Fig. 5. Derivation of track from slant ranges measured for two successive transits. $C'$ represents the projected position of Cambridge for the previous transit

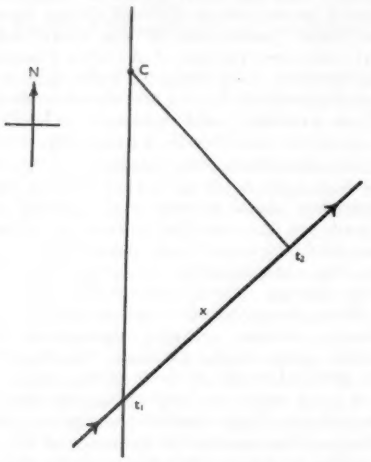



Fig. 6. Determination of the track by combining the two methods

Examples of records obtained for tracks passing within 650 km. and 250 km. are shown in Fig. 4.

By making measurements of the slant range to the track on two or more successive transits, it is possible to determine the true track and height by triangulation. Fig. 5 shows the graphical method used in

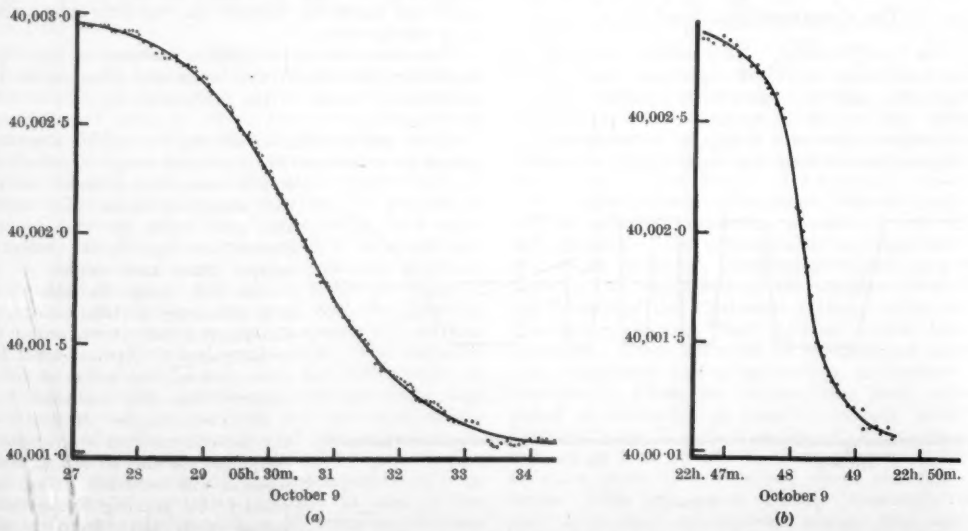



Fig. 4. Variation of the received frequency for tracks having slant ranges of (*a*) 650 and (*b*) 250 km.

which the measured slant ranges are projected on to a plane perpendicular to the direction of the orbit at the latitude of Cambridge; the lateral movement of Cambridge between successive orbits allows a normal range triangulation method of plotting to give the height and track of one of the chosen transits.

A similar method based on the measurement on the same transit of the slant ranges from two or more spaced receiving stations was also used; for this method the observations made by the Post Office receiving stations at Baldock and Banbury were combined with our own.

In most of our observations, the results of both interferometric and Doppler methods were combined; the time of meridian transit ($t_1$) (Fig. 6) and the time of closest approach ($t_2$) allow a determination of the intervening track $x$, and hence of the latitude at which the meridian is crossed.

## Derivation of an Approximate Orbit

The ground range at closest approach may then be combined with the measured slant range to give the height independently of that derived by fitting the recorded times of crossing the grid lines.

Measurements made during the period October 6–20 have been reduced to provide the following details of the orbit; these figures differ slightly from those published earlier[1] because more detailed corrections have been applied and additional observations have become available.

Full details of the observations have been communicated to the Superintendent of the Nautical Almanac Office, who has undertaken the calculation of the orbit, but in the meantime we have derived a provisional orbit for October 15·0 the details of which are given below:

| | |
|---|---|
| Inclination | 64° 40′ ± 10′ |
| Period between successive northward crossings of lat. 52° 12′ | 5750·0 solar sec. ± 0·3 sec. |
| Rate of decrease of period | 2·2 ± 0·1 sec. per day |
| Height at latitude 52° 12′ on northward passage | 223 km. ± 10 km. |
| Height at latitude 52° 12′ on southward passage | 470 km. ± 15 km. |
| Semimajor axis | 6,937 km. |
| Eccentricity | 0·053 ± 0·001 |
| Latitude of perigee | 36° N. ± 3° |
| Longitude of ascending node | 308° 00′ ± 15′ |
| Retrograde motion of ascending node | 2° 39′ ± 5′ per day |
| Meridian passage at Cambridge on October 15 | 21 08 41 U.T. |
| Height above mean radius of Earth at perigee | 197 ± 10 km. |
| Height above mean radius of Earth at apogee | 934 ± 10 km. |

Because of its interest in connexion with the fall-in of the satellite, the measurements of the true period are plotted in Fig. 7; the present change of period corresponds to a decrease in height at apogee of about 3·5 km. per day.

By extrapolation from the observations, it has been possible to provide predictions of transits over the British Isles for one or two days in advance, with an accuracy of about 50 km. in track, 10 km. in height, and 3 sec. in time of meridian transit.

## Variation of the Intensity of the Received Signal

The strength of the signal frequency shows remarkable and complicated fading patterns in which regular variations having periods between 0·5 and 10 sec. may be seen. Typical examples are shown in Fig. 8.

A number of effects could contribute to such variations:

(*a*) Spinning of the satellite could cause a variation of the intensity due to the polar diagram of the transmitting aerial. Such variations might have a frequency $f$ or $2f$, where $f$ is the frequency of spin; the magnitude of the effect will depend on the aerial system and the inclination of the spin axis relative to the aerial axis and the line of sight.

(*b*) Any plane-polarized component of the emitted signal would produce a variation in the signal received by a linearly polarized aerial if the satellite were spinning; this variation might also have a frequency $f$ or $2f$, depending on the aspect, and its magnitude would also vary markedly with aspect.

(*c*) The Earth's magnetic field will cause Faraday rotation in the ionosphere, and as the satellite moves

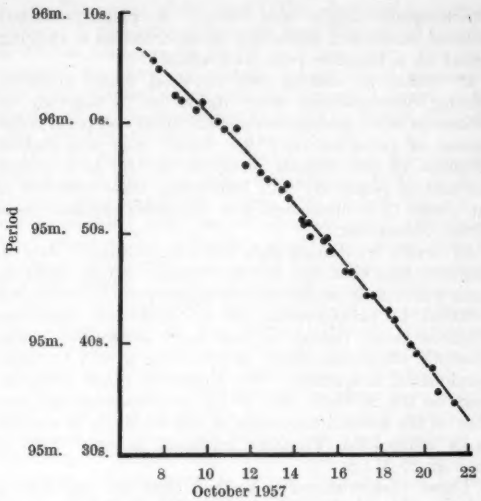



Fig. 7. Variation of the true period

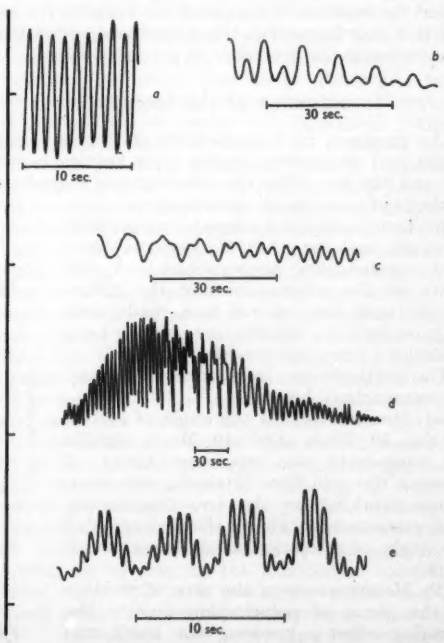



Fig. 8. Examples of fading records

the rotation angle will vary; a plane-polarized emitted wave will therefore be received as a varying signal on a linearly polarized aerial.

In order to distinguish between these possible effects, observations were made on a number of occasions with aerials having mutually perpendicular planes of polarization; we found that the fading patterns of the signals received on the two aerials differed in phase by $\pi/2$, indicating that rotation of the plane of polarization was the predominant cause of the variations.

In order to distinguish between rotation due to spinning and that due to the Faraday effect, observations were made on different frequencies; the Faraday rotation is proportional to $\lambda^2$, and will therefore produce faster fading on the lower frequency transmission, while the effect of spinning would be independent of frequency. We therefore made observations on the 20 Mc./s. and 40 Mc./s. transmissions, and also on the second harmonic of the 40 Mc./s. transmissions where the Faraday rotation is only 1/16 of that at 20 Mc./s.

These observations indicated that the satellite is spinning at seven revolutions per minute; the axis of spin could in principle be deduced from records such as Fig. 8 (*b*), which may show the transition of the line of sight through the cone angle traced out by the aerial axis. In practice it is not possible to find the true axis of spin, because it seems probable that owing to the aerial systems the atmospheric drag deduced under the heading "Other Investigations" will not act precisely through the centre of gravity of the satellite. If the effective centre of the frontal area is displaced by more than about 1 mm. from the centre of gravity, the couple exerted by the air drag will cause a precession of the axis of spin of at least ¼ radian per orbit. It is therefore impossible to relate the observed fading curves on successive transits.

Having determined the spin frequency, it is possible to find the true rate of change of the Faraday rotation, and this may be used in the manner described below to investigate the structure of the ionosphere.

## Investigation of the Ionosphere

The presence of a transmitter at varying zenith angles and at various heights over Britain between 200 and 500 km. offers the possibility of entirely new methods of ionospheric investigation.

We have considered a number of possible methods, and for most of them we have made preliminary observations. A full study of the potentialities of the different methods has not yet been made, and only preliminary results have so far been abstracted from our records.

The methods we have considered may be summarized briefly:

(*a*) Measurement of the angle of arrival of the 20 Mc./s. and 40 Mc./s. signals by comparing the apparent times of crossing the grid-lines of similar interferometers working on the two frequencies. This measurement allows the deduction of the angle of refraction at different zenith angles.

(*b*) Measurement of the rate of rotation of the plane of polarization due to the Faraday effect; knowing the track and the inclination of the Earth's field to the line of sight, it is then possible to deduce the rate of change of $\int N dh$ up to the satellite.

(*c*) Measurement of the shape of the Doppler curve gives the rate of change of phase path; from a knowledge of the true track, or better from a comparison of the rates of change at two frequencies, $\int N dh$ can again be derived.

Methods (*b*) and (*c*) are considerably simplified if the rays can be supposed to be undeviated; it is therefore desirable to use high frequencies, especially when observing at large zenith angles. In method (*b*) we have therefore made observations on the 40 Mc./s. transmission and on its harmonic at 80 Mc./s.

By making such observations at large zenith angles where effects associated with the Earth's curvature become pronounced, it may also prove possible to determine the distribution of electron density with height, $N(h)$.

Owing to the ellipticity of the orbit, the height of the satellite changes appreciably during the period of observation; it is therefore possible to derive $N(h)$ over a limited range of $h$ directly from the observations of $\int N dh$ throughout the transit. In the present observations this method has not been used extensively, because that part of the track over which the height is changing rapidly occurs at present near sunrise and the satellite is therefore moving in a region which cannot be supposed to be uniform horizontally.

A further possible method of deriving $\int N dh$ has been suggested by the observation that fading which we associate with the spin of the satellite is frequently accompanied by a marked irregularity in the Doppler curves. This effect may be caused by the periodic reversal of the sense of the circularly polarized component of the satellite transmission as it spins; observation of the apparent change of frequency then allows a direct measure of the difference in phase path of the ordinary and extraordinary waves.

We have as yet made no study of the additional variations of signal strength which occur when the satellite is near or below the optical horizon.

*Preliminary Results.* Some preliminary results have been obtained from the interpretation of the fading curves in terms of Faraday rotation; in this analysis simple curves of the type shown in Fig. 8 (*a*) were selected, and it was found that many of these showed fading speeds at 20 Mc./s. and 40 Mc./s., which were closely proportional to $\lambda^2$, as

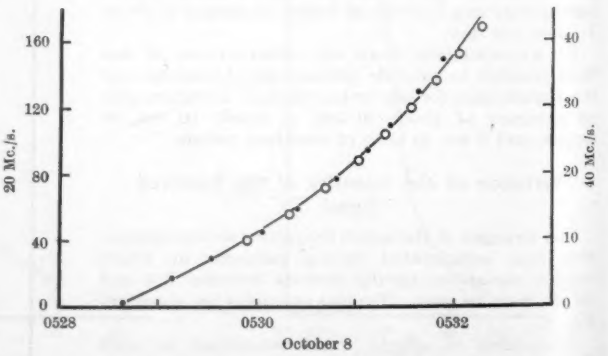



Fig. 9. Variation during the transit of the speed of fading at 20 Mc./s. (●, left-hand scale) and 40 Mc./s. (○, right-hand scale), showing that the speeds are closely proportional to the square of the wave-length

would be expected if the fading were due to Faraday rotation. An example of fading curves in which the spin of the satellite produced a negligible effect is shown in Fig. 9.

From computations of the geometry of transits for which such curves have been obtained it has been possible to determine $\int N dh$ up to the height of the satellite.

For example, observations at 0330 on October 20 when the satellite was at a mean height of 475 km. indicated a total electron content up to this height of $1{\cdot}8 \times 10^{13}$ cm.$^{-2}$.

## Other Investigations

(*a*) *Density of the Atmosphere.* The observed decrease in the period of the orbit allows an estimate to be made of the air drag. We have used the published mass of 84 kgm. and diameter of 58 cm. and have neglected the cross-section of the aerials; on the assumption that the gas particles adhere temporarily to the surface of the satellite and leave with thermal velocities, we have estimated that the mass of air encountered in each orbit is 1·8 gm.

Because the orbit is elliptical, this result can only be used to derive the air density if the scale height is known. Assuming a temperature of 1,000° K., the density at a height of 200 km. was found to be about $4 \times 10^{-13}$ gm. cm.$^{-3}$.

Continued observations of the changes in the orbit should allow the determination of both density and temperature as functions of height.

(*b*) *Precession of the Orbit.* The observed retrograde motion of the ascending node over the period October 8–18 was found to be $2° 33' \pm 5'$ per day. For comparison we have computed the expected precession for the observed orbit and the accepted figure of the Earth using the relationship given by Davis, Whipple and Zirker[2], and find a value of 3° 45′.

It does not seem possible to account for this discrepancy in terms of secondary effects of the air drag, or by electromagnetic forces. It is possible that a more detailed analysis of the expected precession may resolve the difficulty, and it is clear that an improved measurement of the precession by continuing the present observations is of great interest.

The work described here has involved practically the whole staff of the Mullard Radio Astronomy Observatory, as well as several of the members of the Ionosphere Section of the Cavendish Laboratory.

Besides our own observations we have been able to make use of a large number of valuable recordings provided by the Post Office receiving stations at Banbury, Baldock and Brentwood, by the Marconi Research Laboratories at Great Baddow and by Mr. F. W. Hyde of the Radio Section of the British Astronomical Association. We are most grateful for their co-operation, and would like to thank all those whose advice we have sought, in particular the Superintendent and the staff of the Nautical Almanac Office.

[1] *Nature*, **180**, 784 (1957).
[2] Davis, R. J., Whipple, F. L., and Zirker, J. B., "Scientific Uses of Earth Satellites" (1956).

# UNDERWATER SWIMMING AND DIVING

A SESSION of Section I (Physiology) of the British Association, held on September 11, was devoted to the problems of underwater swimming and diving. The meeting was opened by Dr. H. J. Taylor (Royal Naval Physiological Laboratory, Alverstoke), who discussed the physiological aspects, and he was followed by Capt. W. O. Shelford, R.N. (retd.) (Siebe Gorman and Co. Ltd.), who gave an account of apparatus development. M. Frederic Dumas of the Groupe d'Etudes et de Recherches Sous-marines, Toulon, then presented three films illustrating some of the activities of underwater swimmers.

Dr. Taylor opened with a warning against the indiscriminate use of underwater apparatus by the uninitiated. He urged those interested to join recognized clubs, to become well acquainted with the apparatus, to acquire as much information as possible about the hazards of underwater swimming and never to dive alone but always with a companion. In particular he emphasized the serious dangers in the use of oxygen sets by amateurs.

Dr. Taylor said that the problems raised by diving and underwater swimming, quite apart from the technical and engineering aspects, are those of the effect upon the body of exposure to increased pressure.

It is a remarkable fact that in the recent British world record deep dive a man tolerated an exposure to a pressure of 17 tons per square foot. This is because the body, except for some sealed air spaces, is made up of solids and fluids which are, for all intents and purposes, incompressible. Pressure is transmitted to all parts and equalized. This of course implies that air must be breathed at the pressure to which the diver is subjected. A swimmer who makes a dive to 100 ft. (that is, to a pressure of 4 atm. absolute) merely by holding his breath will have his lung volume compressed to about one quarter of its original volume. This is approximately the volume of the residual air, that is, the air left in the lungs after the greatest possible expiration. Any further increase of pressure will produce a condition known as a 'squeeze', and fluid and blood may be forced into the lungs; this damage may be severe. Further increase of pressure may cause the chest wall to collapse. This 'squeeze' may also occur if the pressure of air within the helmet of a diver falls below the external pressure. The shoulders and body will be pushed with great force into the rigid helmet with, usually, fatal results. The ear is very susceptible to damage by pressure, which, when applied to the ear-drums, must be equalized otherwise rupture will occur. This equalization is accomplished by allowing air to pass up the Eustachian tube to the middle ear. This is a procedure which the diver himself must carry out and is known as 'clearing the ears'. Difficulties are sometimes encountered in

equalizing the pressure in the accessory sinuses and severe pain may result.

Problems can also arise when the pressure on a diver or swimmer is reduced, particularly when he comes to the surface. Normally, on rising towards the surface the pressure of the air in the lungs is maintained almost equal to the external water-pressure by means of a relief valve on the helmet or breathing apparatus. If the relief valve fails to function or if the ascending man holds his breath a positive pressure may be built up inside the lungs. The lungs would become over-expanded and some air sacs and blood vessels become torn. Air could be forced into the ruptured tissues or blood vessels producing spontaneous pneumothorax in one case or air embolism in the other. The results of this may be serious in the extreme, and recompression to the original depth or deeper is essential in order to prevent fatal consequences. Death has occurred after an ascent from only fifteen feet. These dangers can be overcome only by experience and careful training, and this fact cannot be over emphasized.

There are, however, more hazards due to physiological processes concerned with the respiration of gases under pressure. Almost all gases, even the so-called inert ones—nitrogen and the rare gases—exert their own special effects, when breathed at higher partial pressure than normal.

Oxygen is probably more important from the military aspect than it is from the purely recreational. If it is essential that an underwater swimmer must not give his position away with bubbles, then pure oxygen must be breathed in association with an absorbent for carbon dioxide. The hazards of breathing this gas are, therefore, almost entirely confined to operational duties.

Oxygen produces two effects—the Lorrain–Smith or chronic effect and the Paul Bert or acute effect. The former, in the main, is produced by the irritant effect of oxygen, when breathed at between 0·6 and 2 atmospheres, on the delicate membranes of the lung. Much research on this problem has been carried out, but since the effect only occurs after breathing oxygen for many hours it is not looked upon as being a hazard of diving or other underwater operation.

The Paul Bert or acute effect is much more important. This appears when oxygen is breathed at a partial pressure in excess of 2 atmospheres. The greater the pressure the shorter the time of onset of signs and symptoms of the toxicity of oxygen. In man and other mammals this is characterized by a convulsion, epileptiform in character, and the onset of such an effect in an underwater swimmer can be most dangerous. The depth and duration of underwater operations involving oxygen breathing is therefore severely limited.

Much research has been carried out on the cause of this phenomenon, without, it must be admitted, a great deal of success. This is not surprising since comparatively little is known about epilepsy itself. One of the main theories postulates interference in oxygen breathing with the dual function of hæmoglobin. If oxygen at partial pressures greater than two atmospheres is breathed, then there is sufficient oxygen dissolved in simple solution in the plasma to satisfy the needs of the body under conditions of comparative rest. No reduced hæmoglobin is available, therefore, for transport of carbon dioxide and one might expect an accumulation of this gas in the body tissues. It is suggested, therefore, that the effect is really due to excess carbon dioxide in the tissues. Experimental evidence is available which appears to confirm this idea, since the tension of carbon dioxide in the tissues during oxygen breathing shows a marked rise. In addition, it is known that the respiration of a low proportion of carbon dioxide with the oxygen greatly enhances the effect. However, more recent experiments by some workers in the United States show that there is reduced hæmoglobin available in the brain and the normal removal of carbon dioxide can take place. If it is assumed, as is generally the case, that the brain is the source of the manifestation of oxygen poisoning, then a blow has been dealt at the Gesell hypothesis. The American work is, however, open to some criticism. Other theories are (*a*) that oxygen interferes with brain metabolism, for example, that it affects enzyme systems; (*b*) that neuro-muscular transmission is impaired.

The Royal Navy has been seeking a suitable drug which can be given to an underwater swimmer to increase his resistance to oxygen poisoning, and some success has been obtained.

There is another effect characterized by sudden lack of consciousness at comparatively shallow depths which has been ascribed to breathing oxygen. This is sometimes called 'shallow-water black-out' or 'oxygen syncope'. The cause is obscure, but experimental work is proceeding. It may be due to a cerebral vasco-constriction by oxygen.

Nitrogen, when breathed under pressure, exerts a narcotic action. There is a slowing up of mental processes, and fixation of ideas is a characteristic response. Frequent errors are made in simple arithmetic and in the recording of information. These responses may be similar to those associated with anoxia or with alcoholic stimulation. If nitrogen in the oxygen–nitrogen mixture is replaced by helium then the effect is much reduced. It may be that the fact that the oil/water solubility ratio for helium is much less than that for nitrogen has some bearing on the problem (cf. the Meyer–Overton law). It has also been suggested that decreased elimination of carbon dioxide due to decreased pulmonary ventilation produced by the heavy gases might be a factor, but measurements of alveolar carbon dioxide under conditions of high pressure have shown this to be normal and have disproved this hypothesis.

Recent work, involving electro-encephalograph records, has been rewarding. Normally the occipital alpha-rhythm shows an abrupt fall in amplitude (blocking) when a subject concentrates on a problem. After exposure to a pressure of four atmospheres in air the time to give an answer to a simple calculation is increased and further exposure leads to abolition of the blocking. On returning to atmospheric pressure, this process is reversed. Using different pressures it is found that the time to abolition of the blocking is inversely proportional to the square of the pressure, suggesting a diffusion process. On replacing nitrogen by helium, blocking is not abolished. It seems, therefore, that nitrogen is responsible for these effects. Consequently, for deep dives a helium–oxygen mixture replaces air.

Nitrogen and all the inert gases produce an effect, only observed when the pressure drops, due to the quantity of gas dissolved in the body. Exposure to these gases under pressure produces an increased tension in tissue, dependent on the depth and duration of the dive and on circulatory efficiency. When a

certain quantity of inert gas in the tissues is exceeded, direct decompression to atmospheric pressure will lead to the formation of bubbles and the so-called 'bends'. This has led to the introduction of diving tables; so that a man is not brought directly to the surface but has a series of stops at different depths and times depending on the nature of the original dive.

Several of these diving tables have been produced, but all have some unsatisfactory features. This is because of a lack of fundamental information regarding inert gas exchange in tissue. Research is therefore proceeding at the Royal Naval Physiological Laboratory on this subject and some success has been achieved. It would appear that only one type of tissue is involved, and that saturation and desaturation are not reversible, as has previously been assumed. The removal of dissolved gas on decompression is retarded by the presence of bubbles which may not be of sufficient size to produce signs of bends. The fact that exposure to pressure appears to produce these silent bubbles must be taken into account in the calculation of safe decompression tables.

As regards carbon dioxide, if the absorbent canister is working efficiently in a closed-breathing set there should be no danger from this gas. Nor should it be a hazard in deep diving if the flow of gas is sufficient to wash out the carbon dioxide.

Naturally, there was not sufficient time to enlarge on all the problems arising from diving and underwater swimming. Such a one as protection from the cold was not mentioned, but it has its importance. There is, however, one phenomenon which is becoming more and more important as dives become deeper and deeper, and that is the voice-change produced by increased pressure and also by breathing helium. Communication thus becomes more and more difficult, and the audience was asked to listen to a tape recording of a man speaking under pressure. The explanation of this effect is not yet clear, but in the recent world deep dive to 600 ft. it was found almost impossible to understand what the diver said.

This recording was of an Irishman repeating the well-known verse, "In Dublin's fair city . . . singing cockles and mussels alive, alive O!" at a pressure of 132 lb./sq. in. (about 264 ft. of sea water). The euphoria and speech distortion produced by nitrogen under pressure were well illustrated.

Capt. W. O. Shelford spoke next; he classified diving apparatus into four types: (1) self-contained closed circuit; (2) self-contained open circuit; (3) surface-supplied open circuit; (4) surface-supplied closed circuit.

The best known set of the first group is that designed by Sir Robert Davis for submarine escape. This involves the use of pure oxygen, carbon dioxide being absorbed by 'Protosorb'. Other forms of oxygen diving apparatus were greatly used during the Second World War for all types of offensive operations. The great advantage of oxygen is the compact nature of the set and the absence of tell-tale exhaust bubbles. It also gives great endurance, for example, that used by human torpedo-men had a tested endurance of six hours in 25 ft. of water with a considerable margin of reserve. One of the greatest problems in this sort of set is the absorption of carbon dioxide. Much valuable research work was carried out at the Chemical Defence Experimental Establishment, Porton, both on canister design and in the control of the absorbent chemicals.

A great advance was made during the Second World War in the use of mixtures of oxygen and nitrogen for breathing in a semi-closed circuit apparatus. The theory of mixture breathing was developed by Prof. J. B. S. Haldane and Dr. K. W. Donald and the idea is to give as much oxygen as possible in the mixture (and so provide maximum endurance) consistent with the least danger of oxygen poisoning. The optimum concentration of oxygen depends upon the depth of the dive. The set is a semi-closed circuit one giving partial rebreathing with a flow fixed according to the depth by a regulator which is compensated automatically for change in sea pressure. The regulator delivers a constant mass of gas at any diving depth. Mixtures have been used in Britain for many years with success, and Norway and the United States are now beginning to experiment with their use. The French have recently developed a mixture breathing set which supplies gas on demand without the use of a regulator.

Possibly the greatest interest since the War is in the compressed-air open-circuit apparatus. This is commonly known as the aqualung and its use has been popularized by Capt. Cousteau, M. Frederic Dumas and their associates. Air is stored in bottles at high pressure and delivered to the diver at the pressure of the surrounding water to be compensated instantly as the diver descends or ascends. This has to be done by a demand valve capable of supplying sufficient air to a diver even when he is making the maximum possible inspiratory effort. Being an open-circuit apparatus, the endurance varies with the depth. As regards surface-supplied open-circuit apparatus, there is the standard rigid-helmet type which has been in use for more than a hundred years. No change in principle—which is to compress air on the surface and supply it to the diver by a hose at a pressure equivalent to his depth—has been made, but naturally, suits, compressors and all ancillary equipment have improved. A recent variation is to supply air to the diver at about 100–50 lb./sq. in. and he regulates his own supply by breathing from a demand valve.

This last class of diving is that using the partial self-contained closed-circuit system, almost exclusively in very deep diving. On open circuit it was found that carbon dioxide tended to accumulate in the helmet due to pocketing. This led to the adoption of the Siebe–Gorman injector re-circulating system which was applied to the standard diving dress. In this system, air is supplied at a pressure higher than the ambient sea pressure, sufficient to maintain a constant flow through an injector. This injector feeds into a Venturi tube, creating a partial vacuum in a carbon dioxide absorption canister worn on the back of the diver. The air containing carbon dioxide is therefore drawn through the canister and back into the helmet. Very much less air from the surface is therefore required. As diving depths become greater so the problem of nitrogen narcosis becomes more important. Nitrogen is therefore replaced by helium. At first considerable difficulties were encountered and the construction of the helmet had to be improved still further and, since helium is so much less dense than nitrogen, new injectors and venturis had to be designed.

World record dives to 540 ft. in 1948 from H.M.S. *Reclaim* under Capt. Shelford's command and to 600 ft. from the same ship in 1956 testify to the success of these developments.

Another field in which considerable advance has been made is that of divers' clothing. Two-way stretch nylon, proofed with neoprene, is being used to give a supple suit with maximum protection properties. Despite much research, it is still thought that the standard diving woollen undergarments are the best for protection against cold.

Capt. Shelford went on to predict further developments. He foresaw a time when all suits would be of rubber- or neoprene-proofed 'Terylene' fabrics fitted with light-weight ball-race shoulder and waist joints. The special copper helmet inside which the diver rotates his head may be replaced by a comparatively tight-fitting helmet rotating and elevating at the neck joints so that its volume and buoyancy can be greatly reduced. There could be considerable development in the open-circuit aqualung set if new materials, allowing for greater charging pressures, were allowed by the authorities for the construction of cylinders. Capt. Shelford ended by saying that he had no doubt that industry would supply any equipment which the scientist needed to provide for deeper and deeper depths.

The last part of the meeting was devoted to the showing by M. Frederic Dumas of three films. The first, in black and white, was of some of the experiences of cave diving. The film started by giving an insight into the organization required before such a project could be undertaken, how the interest of the local population was aroused and how the morale of the divers was maintained in the local cafés. In the caves themselves the pictures were most fascinating, particularly when attempts were made to find the sources and direction of flow of the water.

The second film, in colour, was an account of an exploration for oil in the Persian Gulf carried out for the Kuwait Oil Company. Fine seascapes and pictures of fish and animal life were shown. A cage for protection against sharks was a reminder of one of the special hazards in this sort of work.

The third film, again in colour, showed the discovery and investigations of some Roman galleons sunk in the Mediterranean. Marble pillars and other portions of buildings which were being transported in the galleon when it sank were in a remarkable state of preservation. Later, the film showed how an underwater swimmer can help in tunny fishing. This looked particularly hazardous, but M. Dumas assured his audience that this was not so.

During the subsequent short discussion members of the audience gave accounts of the work of their own sub-aqua clubs, endorsing the warnings that Dr. Taylor gave earlier on. Questions were asked about the reported failure of some men to carry out quite simple tasks at shallow depths, when nitrogen narcosis could be ruled out. It was suggested that this was probably due to apprehension and anxiety.

H. J. Taylor

# THE ORIGINS OF LIFE

## MOSCOW SYMPOSIUM

THE Academy of Sciences of the U.S.S.R. acted as generous host to the first of the specialist symposia that the International Union of Biochemistry has decided to arrange in years when there is no international congress. The symposium was organized by Prof. A. I. Oparin; it was on "The Origin of Life on the Earth", and this is also the title of the new edition of a book by him that Dr. Ann Synge has recently translated into English.

About sixty papers were circulated, read in summary, and then discussed during three and a half well-filled days. This was certainly the most ambitious attack on the problem that has as yet been made, but, contrary to the claim that was often made at the symposium, it was by no means the first serious scientific attack on it. At the end of last century and the beginning of this one the British Association dealt with the subject regularly. Huxley, Tyndall, Schafer and others had a clearer grip on the nature of the problem than most contemporary writers. They also often have priority. If participants in future symposia on biopoesis would read the old literature we might be spared the embarrassment of hearing eminent scientists portentously making suggestions that were familiar 50–80 years ago.

There is now general agreement that life can arise from non-living matter but there is disagreement about how often it does so. The possible points of view are set out in Table 1. Possibilities 1 and 2 are

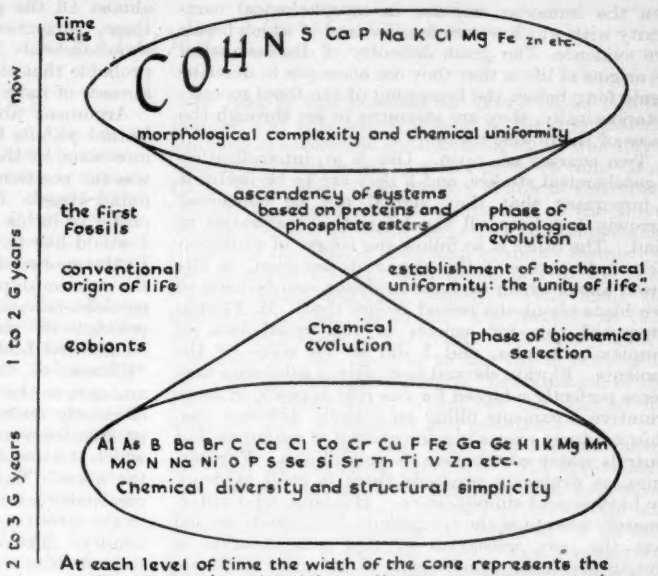
Table 1. Biopoetic Theories

| | No. of biopoeses | General character |
|---|---|---|
| 1 | None | Life has always pervaded space and an apparent origin is simply a transfer from place to place |
| 2 | One | Creation by divine intervention |
| 3 | One | Evolution on Earth by the action of inevitable, normal processes |
| 4 | Several | Repeated co-ordination of eobionts or subvital units |
| 5 | Innumerable | Classical and medieval idea that life appeared whenever there was a suitable environment |

not now often advocated, but 1 will soon become amenable to experimental test when astronauts set out to look for what Haldane calls "astroplankton". Possibility 5 was effectively disproved during last century, not so much by the work of Pasteur as by the existence of the food-canning industry. That leaves 3 and 4. Many people advocate 3 because they claim that the biochemical uniformity of present-day life, and the preponderant use in proteins of amino-acids of only one of the two antipodal series, suggests a common origin. This point of view was maintained at the symposium by R. L. M. Synge; but it does not seem to me to pay sufficient attention to the operation of food chains in Nature. If any group of organisms started to use one antipodal series it would be advantageous for any other group, even slightly dependent on the first, to come into line. And there are obvious advantages in using one series only. Though biopoesis is probably a rare event it is probably not a unique

one. Disproof of this point of view will be difficult. It is hard to experiment on rare events and, as Darwin long ago pointed out, any new intruder into the living domain would now be immediately used as food by a longer established organism.

The Moscow discussion, like most similar discussions, got bogged down from time to time in metaphysics about the nature of life. In spite of official adherence to a Marxist materialist philosophy, a surprisingly large proportion of the Russian participants appeared to be Platonic Idealists. They realized that they could neither define nor unequivocally recognize 'life', but they were none the less certain that there was such an entity to be recognized. This was also the attitude of many members of the group from the United States. Even the 'cold war' cannot contend with Idealism. My attitude, which might be labelled Empirical Nihilism, is that the statement that a system is or is not alive is a statement about the speaker's attitude of mind rather than about the system, and that no question is scientifically relevant unless the questioner has an experiment in mind by which the answer could be approached. When we are concerned with extreme states, such as the higher plants and animals on one hand and rocks and chemicals on the other, there is little uncertainty. It is when the borderline is being considered, as with viruses or some metabolically active fragments from cells, that definition could be useful and is impossible.


Time axis
now
1 to 2 G years
2 to 3 G years
C O H N S Ca P Na K Cl Mg Fe Zn etc.
morphological complexity and chemical uniformity
ascendency of systems based on proteins and phosphate esters
the first fossils
phase of morphological evolution
conventional origin of life
establishment of biochemical uniformity: the "unity of life"
eobionts
Chemical evolution
phase of biochemical selection
Al As B Ba Br C Ca Cl Co Cr Cu F Fe Ga Ge H I K Mg Mn Mo N Na Ni O P S Se Si Sr Th Ti V Zn etc.
Chemical diversity and structural simplicity

At each level of time the width of the cone represents the number of ways in which living or lifelike systems worked.
The size of the atomic symbol is an indication of the contribution that element may have made to the process at the time.

Fig. 1

But the history of science offers many examples of useful discussions on ill-defined or undefinable themes. The Moscow symposium was another. The first few papers were on the chemical nature of Earth's probiotic atmosphere and surface; they demonstrated that there is no basis for dogmatism. Of particular interest was the revival by P. N. Kropotkin of the idea that petroleum could have a non-biological origin. The case that was made out was so convincing, although the idea has been condemned by most authorities for half a century, as to suggest that many other possibilities that are now neglected might be re-investigated. There were then several papers on the types of synthesis that proceed when mixtures of the various substances that have been postulated in the primitive environment are exposed, in the laboratory, to energy sources as diverse as heat, electromagnetic radiation and radioactivity. These demonstrate, what most biochemists have been prepared to assume, that there is no difficulty in postulating a chemically complex 'probiotic soup'. If a theory of biopoesis demands the presence initially of any particular type of chemical compound it would be foolhardy to deny the possibility of its synthesis. It is good to have our assumptions justified: but the main value of this type of experimentation now seems to lie in the possibility that these syntheses may have industrial applications.

The greater part of the symposium was taken up with papers the relevance of which depended on the assumption that life can only exist as a result of the activities of proteins, nucleic acids, high-energy phosphates or whatever type of compound is at the moment fashionable. Undoubtedly all the present-day organisms that have been studied contain all these substances; they also contain fats, carbohydrates and so on. In these circumstances it seems invidious to pick any one as the *sine qua non* of life. We are not even justified in assuming that there was any single type of substance in this unique position. It is just as likely that primitive forms of life, or eobionts, made use of many different mechanisms, and that the mechanisms we see now are the end result of an immense process of evolution and selection. Proteins may be the most efficient rather than the only vehicle for living. On this view a detailed discussion of the contemporary metabolic behaviour of amino-acids, nucleic acids or proteins may have no more to do with the origins of life than a study of the mechanism of a cigarette lighter has with the origins of fire making. Extending this type of scepticism, there is also no reason for the general assumption that life has, at all epochs, been predominantly the affair of the carbon compounds. Small, atypical regions, in which elements that no longer play a large part quantitatively were concentrated, may have been the sites of biopoesis.

This outlook is illustrated crudely in Fig. 1. There are two cones set apex to apex and the diameter of a cone (the abscissa) at any level of time (the ordinate) represents the number of different ways in which systems with living or lifelike properties worked. The lower cone represents an immense chemical diversity narrowing down as a result of biochemical selection to give a few forms of life operating on a more restricted group of efficient chemical mechanisms. From that point on there has been little or no increase in biochemical complexity but there has

been the immense increase in morphological complexity with which we are familiar and of which fossils give evidence. The great difficulty of discussions on the origins of life is that they are attempts to describe events long before the beginning of the fossil record; metaphorically, they are attempts to see through the apices of the double cones.

Two courses are open. One is an intensification of geochemical studies, and if they are to be useful it is important that they should not be conceived narrowly but keep all the biopoetic possibilities in mind. The other is to follow the course of evolution backwards to see if the apparent direction, in the period about which we have evidence, can be used to give hints about the period before that. M. Florkin attempted this for aspects of the metabolism of complex molecules, and I did so for some of the elements. Florkin showed how often a substance that seems perfectly adapted for one role appears in more primitive organisms filling an entirely different one. Thus oxytocin exerts uterine control in mammals but controls water metabolism in amphibians. Furthermore, as evolution proceeds there is good evidence for biochemical simplification. Haldane, who unfortunately was not at the symposium, has already argued that the only exception to this generalization is protein synthesis, which seems to get more elaborate in the higher organisms. If this is indeed so, and if we follow the logic of the generalization, it suggests that proteins, far from being the original essential vehicles of life, are a relatively recent innovation. The efficiency given by proteins may have made them dominant. Thus it is the vertebrates that use them for nearly all purposes, structural as well as catalytic. As we descend the evolutionary scale their structural and protective functions are increasingly taken over by polysaccharides and matrices loaded with mineral crystals. The use of the elements suggests a similar trend. It is primitive organisms and not the most highly developed that have the most catholic approach to biochemistry and use vanadium, selenium, the halogens, aluminium, silicon and so on, most readily. That is why I give all these elements an equal status with the contemporary bio-elements on the base of the lower cone of Fig. 1.

If this approach to the problems of biopoesis is valid it follows that the most relevant contributions that comparative biochemistry could make would come from a detailed study of the most primitive contemporary organisms and of those organisms which, although able to live in an environment free from other metabolizing systems, nevertheless have extremely limited synthetic capacity. The first group includes such things as sponges, ferns and liverworts; a study of their peculiarities would give us more information about the range of activities of which the now extinct forms of life may have been capable. The second group includes those saprophytic bacteria that need the most elaborate media for growth, for they probably have the smallest range of intrinsic metabolic ability and so would give us information about how small a group of co-ordinated metabolic activities is needed to satisfy at least some of our æsthetic requirements for a living system. It is unfortunate therefore that most attention was devoted at the symposium to viruses and autotrophic bacteria. The former are irrelevant because they do too little and only exist by courtesy of the synthetic mechanisms of a highly evolved host; the latter because they do too much. They are indeed able to carry out almost all the general biochemical operations. All these capacities could scarcely have developed simultaneously in an early form of life. It is more probable that they are a response to the competitive stresses of more recent times.

Argument about evolution presents many intellectual pitfalls for the imprudent. J. D. Bernal fell into some of them with consequent inversion. This was the position in which, according to Engels, Marx found Hegel. Marx put Hegel on his feet and put posterity in his debt by making the Dialectic useful; I would like to perform a like service for my friend. In the course of making some valuable points about the relationships that will necessarily exist between particles as systems get more complex, he erected the principle of "structural conservatism or inertia" and resurrected L. J. Henderson's old illusions about the "Fitness of the Environment". "Inertia" only amounts to the fact that, when selection has operated efficiently enough to give an organism mechanisms or structures well adapted to the circumstances in which it lives, any change is likely to be a change for the worse. This is a consequence of having achieved reasonable success and it obtrudes itself of necessity in the activities of organisms with a long evolutionary history. The concept of "Fitness" led Henderson towards God; Bernal is a Materialist so it only leads him into trouble. The proposition is that the chemical and physical properties of water, carbon dioxide, etc., are uniquely fitted to give organisms a comfortable environment: and the argument seems plausible until we realize that that is why organisms have evolved with the properties we know. The environment selects those that fit it. It is no accident that the environment suits proteins; had it been different another group of substances would have assumed the dominant role that proteins have in this one. Thus in an environment of liquid ammonia and methane, such as is postulated by some on Jupiter, there would be less need to have macromolecular catalysts, like proteins, because Brownian movement would not be joggling the catalyst's elbow all the time. The reactions there on which life, if any, depends will be slow, but the universe does not seem to be short of time. If Jovial scientists are not very thoughtful they have probably concluded that nothing resembling life can exist on Earth except perhaps in the middle of Antarctica where the sort of molecules that evolution may have selected on Jupiter could be stable. The basic illusion is to assume that ours is the only way of living.

The symposium was valuable because it gave an opportunity for discussion and produced some papers with new relevant information and points of view, and some that may not have been strictly relevant but were sound. It also produced some new nonsense and some nonsense that was not even new; the paper by W. M. Stanley, with the modest title "On the Nature of Viruses, Genes and Life", was outstanding in the last category; he decided that multiplication was an infallible index of the living or non-living status of a system.

Now that the initial step has been taken, it is very much to be hoped that further symposia will be held on themes related to the origins of life. They will produce no succinct answers to the more general questions; but they are essential if the problem is to be defined and if people working in all the different relevant sciences are to see the bearing that their work has on it.

N. W. Pirie

# OBITUARIES

## Sir John Parsons, C.B.E., F.R.S.

JOHN HERBERT PARSONS, who died on October 7, was born in 1868. He was educated at the University of Bristol, where he won many distinctions, and at University College, London. In 1890 he obtained the B.Sc. (Lond.) with honours in physiology. This subject remained his main interest, especially that part of it which concerned visual and cerebral function.

He qualified from St. Batholomew's Hospital in 1892 with the M.B. (Lond.). In 1900 he obtained the B.S. (Lond.) and the F.R.C.S. Eng. In 1901 he was granted a British Medical Association Scholarship and in 1904 obtained the D.Sc. (Lond.).

Parsons decided to become an ophthalmic surgeon, and his first appointment was as curator and librarian to the Royal London Ophthalmic (Moorfields Eye) Hospital. In this post he had control of the pathological laboratory and there laid the foundation and did the necessary research for his great work, "Pathology of the Eye", published during 1904–8. This became the standard work on this subject, and even to-day is a much-used work of reference.

In due course he became surgeon to the Moorfields Eye Hospital and ophthalmic surgeon to University College Hospital and also for a while to the Hospital for Sick Children, Great Ormond Street, London.

Parsons's private practice was carried on at 54, Queen Anne Street, in the house previously occupied by his senior colleague, Mr. Marcus Gunn. The practice grew rapidly, but in spite of this and his ordinary work at the hospitals, he continued his laboratory and research work. In 1903 he was Arris and Gale lecturer at the Royal College of Surgeons. In 1904 he was awarded the Middlemore Prize in ophthalmology and in 1907 the Nettleship Gold Medal. In 1907 he published a small text-book, "Diseases of the Eye". This became very popular, and its tenth edition appeared in 1942.

In the last years of the First World War he was appointed consulting ophthalmic surgeon to the Army in the United Kingdom, and was given the rank of colonel A.M.S., with the task of co-ordinating and regulating the ophthalmic work of the Army. The result was as perfect an eye service as could be managed with the available resources.

All this special knowledge was of use to various ministries and institutions. In 1919 he served on the Advisory Committee of the Air Ministry and in 1922 at the Admiralty; at the Board of Trade on various subjects—sight tests, factory lighting, prevention of blindness; and on the Royal Society's Committee on Glass Workers Cataract. In 1928–32 he was a member of the Medical Research Council. In 1919 he was appointed C.B.E., and in 1922 he was knighted.

In 1919 he was president of the Illuminating Engineering Society and many will remember his inaugural address on "Glare".

In 1917 the *British Journal of Ophthalmology* was founded by the amalgamation of several small publications, and Parsons became the chairman of the editorial board. He devoted much time to this, and it is due to him that this journal obtained and maintained such a very high standard. He continued this work until his retirement from practice in 1939.

In 1936 he was awarded the Howe Medal (United States), and this was a tribute to his international standing as a scientific ophthalmologist. It was during these years that many honours came to him—Hon. LL.D. Edin., Hon. D.Sc. Bristol, Fellow of University College, London, Fellow and president of the Royal Society of Medicine, president of the Ophthalmological Society of the United Kingdom, honorary member of the American Medical Association and of the Australian Ophthalmological Society. Then came the theoretical books, "Mind and the Nation" in 1918 and "Introduction to the Study of Colour Vision". These earned him election to the Royal Society in 1921, and in that year came the "Introduction to the Theory of Perception", which set the seal on his eminence as a philosopher and scientist.

Parsons was a tall, thin man, very modest, rather shy, and he eschewed publicity. He appreciated economy in the use of words, and this sometimes made his published works difficult to follow. He was a shrewd judge of people, no respecter of persons and possessed a mordant wit. The outstanding feature of his character was his intellectual honesty: no hypocrisy, no humbug, no attempt at placating people, no dubious compromises and no pretence. Altogether a life devoted to science and to the welfare of humanity.

A. HAROLD LEVY

## Dr. Kathleen M. Drew

THE death of Dr. Kathleen M. Drew (Mrs. Wright Baker) on September 14 has brought to a tragically early close a career of distinguished and devoted work in phycology in the very difficult field of the red algae. Most of this work was associated with the Department of Cryptogamic Botany in the University of Manchester, where she graduated in 1922, and later worked as a member of staff and as research fellow, first with Prof. W. H. Lang and later with Prof. C. W. Wardlaw; she received the degree of D.Sc. of the University of Manchester in 1939. Dr. Drew was one of the earliest of the Commonwealth Research Fellows and spent two years in the United States, chiefly at the University of California, where some of her early systematic studies on the red algae culminated in the publication of her monograph, "A Revision of the Genera *Chantransia*, *Rhodochorton*, and *Acrochaetium*"; in later studies of this period of her work, for example, on *Spermothamnion* and *Plumaria*, she developed the cytological techniques which formed a basic part of her later work.

After her marriage with Prof. H. Wright Baker, she maintained and developed her interests in the red algae with singular success alongside those of her very happy family life. With the publication in 1944 in *Biological Reviews* of her review on the nuclear and somatic phases in the Florideae, she set the stage for the later developments in her work, where she made notable advances in linking morphological and cytological observations with cultural and physiological investigations into the life-histories and inter-relationships in the Rhodophyceae, that most varied and interesting group of algae. Perhaps one of the most striking results of this experimental attack was the identification of *Conchocelis rosea*

a deep-water, shell-inhabiting phase in the life-history of *Porphyra umbilicalis*, on which she was preparing a further series of investigations.

Dr. Drew's numerous publications have appeared in many scientific journals. She was planning to start work on a book; and though we shall not now have this wider expression of her views, it is indeed fortunate that from time to time she had written articles such as those which have appeared in the *Botanical Review*, *Biological Reviews*, *Phytomorphology*, and in the chapter which she contributed to the "Manual of Phycology", which have reviewed the contemporary position as she interpreted it for the field which she had made so notably her own. She was a familiar figure at international congresses and meetings, which she often attended as an invited speaker.

Dr. Drew was much concerned with the future of phycology in Britain, and felt strongly the need to train younger workers in this field. With this aim in mind, she was one of the prime movers in the formation in 1952 of the British Phycological Society and was its first president. The Society owes much to her enthusiasm and wise guidance during its early years; she was regular in her attendance at its field meetings, and there are many younger botanists who will miss her critical and kindly help on these occasions. For colleagues and research students alike, her place can never be filled. Her work was characterized by outstanding integrity of mind and purpose, and unsparing devotion to the exacting demands of difficult techniques; and these same qualities gave a special value to her advice or help in a variety of fields. To her research students, who came from many parts of the world, Dr. Drew was a stimulating and readily accessible supervisor, as keenly critical of their work as she was of her own; and all of them will have grateful memories of her kindly hospitality and sympathetic friendship.

Mary Calder

# NEWS and VIEWS

## The Artificial Earth Satellite: Observations at Jodrell Bank

After the Russian announcement of the artificial Earth satellite, emergency arrangements were made at Jodrell Bank Experimental Station (University of Manchester) to bring the steerable radio telescope into action as a radar instrument for the detection of the rocket and satellite. Success was achieved on October 11 when both the rocket and satellite were located by radar. Afterwards, measurements were made on two frequencies, out to ranges limited by the Earth's curvature. In addition to this radar work with the telescope, the radio emissions from the satellite have been studied with interferometric and pencil beam systems. It is hoped to publish a detailed account of this work in the near future.

## The Schmiedeberg Award: Dr. E. P. Pick

Dr. Ernest Peter Pick, of the Merck Institute for Therapeutic Research, New York, has received the Schmiedeberg award of the German Pharmacological Society for significant contributions to the progress of pharmacological science. Dr. Pick, who was born in Jaromer, Bohemia, in 1872, and graduated from the German University of Prague in 1896, starting his career as a biochemist in the laboratory of Franz Hofmeister at the Strassburg Physiologico-Chemical Institute. Here Dr. Pick made major contributions to the chemistry of proteins by isolating and characterizing pseudoglobulin and euglobulin, (now known as gamma globulin).

In 1899 he joined the Austrian State Serum-Institut in Vienna, where under Paltauf he became familiar with bacteriology, serology and immunology. It was here that, jointly with Obermeyer, Dr. Pick investigated the chemical properties of antigens and laid the groundwork for Landsteiner's later researches on blood groups. In 1911 Dr. Pick joined Hans Horst Meyer's still young Experimental Pharmacological Institute, where he remained as an assistant until 1924, when he became professor of pharmacology in the University of Vienna. From 1932–33 he was dean of the Vienna Medical Faculty and chief of the Austrian Federal Pharmacological Drug Research Institute.

In 1939 Dr. Pick joined the Merck Institute for Therapeutic Research, which enabled him to continue his scientific research at its laboratories in Rahway, New Jersey. To-day, at eighty-five years of age, he continues as a consultant to the Institute, travelling twice a week to its laboratories to continue his researches, which at present relate to the effect of vitamin $B_{12}$ on cholinesterase. During this period he has also been clinical professor of pharmacology at the College of Physicians and Surgeons, Columbia University, New York City, and associate pharmacologist at the Mount Sinai Hospital, New York. Dr. Pick has made fundamental contributions to research problems in a variety of fields, including the fractionation of proteins, mechanism of shock ('Lebersperre'), and the site of action of hypnotics in the brain.

## Edmund Davy, F.R.S. (1785–1857)

Edmund Davy, who died one hundred years ago on November 5, 1857, made many original contributions to chemistry, but his fame has been completely overshadowed by that of his cousin, Sir Humphry Davy. He was born in 1785 at Penzance, where he received his early education. In 1804, through the influence of his cousin, who was the first professor of chemistry and director of the laboratory at the Royal Institution, he was appointed operator and assistant in the chemical laboratory. The director's laboratory book on September 13, 1809, contains this entry: "The laboratory must be cleaned every morning. . . . It is . . . the duty of Mr. E. Davy to see that it is done and to take care of and keep in order the apparatus". In 1813 Edmund became professor of chemistry at the Royal Cork Institution, and in 1825 he was elected to the chair of chemistry at the Royal Dublin Society. His scientific merits were recognized when on retiring after thirty years he was awarded his whole salary. His honours included fellowship of the Royal Society

and honorary membership of the Société Française Statistique Universelle. An enthusiastic advocate of the extension of scientific knowledge, he founded popular lectures in most of the provinces of Ireland. He was interested in the application of chemistry to agriculture and wrote "An Essay on the use of Peat or Turf, as a means of promoting the Public Health, and the Agriculture, of the United Kingdom" (1850). Among his original work in organic chemistry may be mentioned early experiments on oxymuriatic acid in 1811 and his discovery in 1836 of a hydrocarbon with the molecular formula $C_2H_2$. Acetylene was obtained synthetically in 1862 by Marcel Berthelot. In a letter dated January 13, 1817, Sir Humphry Davy wrote that he had received the credit for his cousin's process of improving bread by magnesia. Edmund Davy died at Kimmage Lodge, County Dublin, at the age of seventy-two.

## Biophysics Research at King's College, London

THE University of London (King's College) has accepted a grant from the Rockefeller Foundation of 121,000 dollars, to be used over the next three years for research in biophysics under the general direction of Prof. J. T. Randall. The new grant marks the continuation of the Foundation's support for this field of research at King's College initiated in 1947. The grant is a recognition of the increasing importance of the contribution of biophysics to the fundamental understanding of biological processes and to the scientific basis of medicine. During the past ten years the Wheatstone Laboratory at King's College has made outstanding contributions to our knowledge of the nucleic acid of the cell (DNA) under Dr. M. H. F. Wilkins, who is deputy director of the Biophysics Research Unit; and Prof. Randall's own group has led the way to the solution of the structure of the collagen of connective tissues and its fibrogenesis. Dr. Jean Hanson's studies (in collaboration with Dr. Hugh Huxley at University College, London) of muscle structure have developed new conceptions of the mechanism of contraction (see *Nature*, 173, 973; 1954). Dr. D. M. MacKay has recently been engaged on problems of visual perception (see *Nature*, October 26, p. 849) which may well be of clinical value and are expected to add to existing knowledge of the working of the cerebral cortex. The Foundation's new grant will be used to maintain and amplify the effort in all these fields of research, which have a fundamental bearing on several important aspects of medicine.

## Royal Society of Arts Endowed Prizes

THE following awards have been made by the Royal Society of Arts as a result of its offer of Endowed Prizes for 1957: Howard Prize of £50 for a treatise on some aspect of the subject of motive agents to Mr. A. E. Johnson, of East Kilbride, Lanarkshire, for his work on "Turbine Disks for Jet Propulsion Units: an account of Work of the Disk Panel of the Ministry of Supply, Gas Turbine Collaboration Committee, during the years 1941–49"; Fothergill Prize of £20 for fire prevention or fire-fighting to Mr. P. B. Smith, of Chapel-en-le-Frith, Cheshire, for his essay "A New Method of Suppressing Fires in Mines". In the opinion of the judge, this entry records the most novel suggestion that has appeared for a number of years.

## Expansion of the Imperial College of Science and Technology

THE number of students at the Imperial College of Science and Technology has risen by 235 since last year and now stands at 2,450. Since the College's expansion programme was started in 1953 the number of students has increased by 800. The rector, Dr. R. P. Linstead, speaking at the College's Commemoration Day ceremony held in the Royal Albert Hall on October 24, said that fifteen new professorships and readerships in the University of London have been established and filled at the Imperial College in the past twelve months. Plans for new halls of residence are well advanced; approval has been received for the clearance of existing derelict properties on the south, east and part of the north sides of the Princes Gardens site to make way for the new halls (*Nature*, 179, 613; 1957), among which is to be Weeks Hall, for which a gift of £150,000 by Messrs. Vickers, Ltd., was announced in March.

## Festival of Films in the Service of Industry

THE premier award in the "Films for Use in Schools" section of this Festival, recently held in Harrogate, was won by "Mirror in the Sky"—a film intended to stimulate scientific interest among pupils of the middle-school age group. "Mirror in the Sky" was sponsored jointly by Mullard, Ltd., and the Educational Foundation for Visual Aids, and produced by Realist Film Unit, Ltd. It is part of the United Kingdom's contribution to a series of modern science films being produced by countries of Western European Union. The subject is the ionosphere and its significance in radio communication; the work of Sir Edward Appleton in proving the existence of the second, higher atmospheric layer which bears his name is outlined.

## Exhibition of New University Architecture

AN exhibition of examples of new university building, admission free, will be held in the Chancellor's Hall, Senate House, University of London, during November 2–15. More than £12 million a year is at present being spent on a programme of reconstruction of universities in the United Kingdom, and it is of great importance that the new buildings should have lasting architectural merit and make a visual contribution to the education of students who live and work in them. The exhibition, which consists of photographs, plans and original drawings of university buildings in Britain and overseas, is roughly divided into sections dealing with lay-out, science buildings and residential areas. At the end of the exhibition the scale is brought down to individual objects that explain in a more tangible way the standard of quality that should obtain throughout universities. The exhibition, which has been arranged by the University Architecture Exhibitions Committee with the support of the Arts Council of Great Britain, will later visit the following university cities: Oxford (November 25–December 10), Cambridge (January), Birmingham (February), and Leeds (March).

## "From Coal to Coke"

IN the Sixth Coal Science Lecture, organized by the British Coal Utilization Research Association, and given at the Institution of Civil Engineers on

October 16, M. Cheradame (of the Centre d'Etudes et Recherches des Charbonnages de France) gave an insight into some of the problems affecting the production of coke in France, and described the researches which his organization had undertaken in an effort to solve them. For many years the French have found it difficult to use certain of their indigenous coals to produce a coke suitable for the blast furnace. Hence, a major task facing the research organization of the nationalized French coal industry has been the investigation of means for producing a good metallurgical coke from the highly swelling coals of the Lorraine, where most of France's iron ore occurs. M. Cheradame recalled that early research into coke-making was largely of an empirical kind. Since 1950, however, basic researches carried out at the Verneuil Laboratories had been supplemented by practical tests on full-scale ovens erected for the purpose at Marienau in the Lorraine coal field. In M. Cheradame's view, three main ideas would dominate future research on coking. These were, first, that the chemical use of hard coal in the form of metallurgical coke was advantageous and should be developed; second, that anthracite and, more generally, smokeless fuels should be used for solid fuel domestic heating; and third, that the range of coals which could be coked corresponded, in many countries, to too small a proportion of coal output and should be extended.

## World Directory of Crystallographers

The Philips Laboratories of Irvington-on-Hudson have recently published a "World Directory of Crystallographers" compiled by Dr. W. Parrish. It lists the names, titles, places of graduate study, addresses and fields of interest of 2,260 crystallographers in fifty-four countries; a preface includes a brief statistical analysis of this information. Much credit is due to Dr. Parrish for his initiative and industry in preparing this work, and to Messrs. Philips for their encouragement and generous contribution to editorial and clerical expenses. Inevitably the first edition suffers from omissions and other shortcomings, but it is satisfactory to learn that if support is adequate the Directory will be published at regular intervals by the International Union of Crystallography. Copies may be obtained at a price of 1·50 dollars post paid from Polycrystal Book Service, 84 Livingston Street, Brooklyn 1, New York.

## Philips Gas Refrigerating Machine

The new Philips *P.W.* 7000 gas refrigerating machine is now available (cf. *Nature*, **176**, 623; 1955). It is a compact, electrically driven, single-cylinder unit, capable of producing five litres of liquid air or liquid nitrogen an hour within 15 min. of starting up. The design of the equipment is unique in that the gas to be liquefied does not undergo compression or pass through any working parts; by this means an exceptionally pure product is assured. The machine will produce liquid gas from those gases which will liquefy at above − 200° C., and temperatures of − 80° C. to − 200° C. can be achieved in a single stage. Under normal conditions, the machine requires only an hour for defrosting and draining of the freezer after 16–20 hr. production. Moisture and carbon dioxide are removed simply by freezing.

## Acceleration of Life-cycle of Southern Pine

An important advance in scientific forestry may be marked by experiments at the California Institute of Technology in which the life-cycle of pine trees has been accelerated more than five-fold. In the Earhart Plant Laboratory, seedlings of the southern pine, commercially the most important pulp wood in the United States, have flowered (produced cones) in a period of only two years. In the forest, this process takes 12–15 years. Selected seeds from single trees of the southern pine were planted in the Earhart Laboratory, where various climatic conditions can be reproduced and controlled. Some of the seeds were placed in conditions of continuous summer, so that the seedlings grew rapidly. Some were planted under conditions of alternate winter and summer, so that several yearly growth cycles were completed in each 12-month period. Finally, some of the trees were first grown to large size in continuous summer, then given a long winter period of dormancy before being returned to summer conditions in which they resumed their growth. Two years after the seeds were planted, this third group of trees produced three female flowers, or pine cones. This is believed to be the first deliberate induction of flowering in a pine tree. The fact that cones have been produced in the southern pine in two years instead of the usual 12–15 years means that it may now be possible to hybridize the trees through repeated generations in the time-span of a single human generation. This will greatly speed up the breeding of trees for faster growth, for better wood, for resistance to diseases and pests, and for growth in climates where they do not now grow.

## Pink Shrimps and Red Prawns

Since the War, prawns of the genus *Pandalus* have been increasing in commercial importance. Earlier in the century they were scarcely fished, since the major grounds of most species of this genus lie in deep water, but modern boats and tackle have made their exploitation feasible. Recently, two important works on the biology and fishery of species of *Pandalus* have appeared. Both species, like most but not all of the species of Pandaloidea which have been investigated, are protandric hermaphrodites, but whereas in *P. borealis* all individuals apparently reverse sex from male to female (a fact which has been attracting some experimental studies recently), in *P. montagui* (*Fish. Invest.*, Lond., Ser. 2, 21, No. 4; 1957) Mistakidis has shown that there is a proportion, about 30 per cent, which are primary females, showing no sex reversal. *P. montagui* is unusual too in inhabiting, during part of the year, shallow inshore waters, in the Thames Estuary and Morecambe Bay, so that the fishery is of long standing. The fishery for *P. borealis*, on the contrary, is recent and rapidly expanding, and Horsted and Smidt have presented an extensive study of the actual and potential fishery in Greenland waters, with accounts of the natural history of the prawn and of the fishing grounds in Greenland (*Medd. Komm. Havundersog., Kbh.*, New Ser., 1, No. 11; 1956).

## Exhibition of Nature Photography

The Royal Photographic Society's annual autumn Exhibition of Nature Photography will be opened at 16 Princes Gate, London, S.W.7, at 4 p.m. on November 28 by Mr. David Attenborough. It will be open to the public during November 29–December 20 (not Sundays). The Exhibition will

consist of prints, transparencies and stereoscopic work, in monochrome and colour. A special feature of this year's Exhibition will be a panel of prints by Mr. Oliver Pike, an honorary Fellow of the Society, who this year has reached his eightieth year and his fiftieth year of membership of the Society. After the London showing, the whole Exhibition is to go to Exeter, where it will be shown during January 6–February 1, in the Royal Albert Memorial Museum.

## Plant Breeders' Rights

A JOINT announcement by the agricultural departments in the United Kingdom says that the Committee on Transactions in Seeds, which is inquiring into the rights and remuneration of breeders of new varieties of plants, is prepared to receive written evidence and views on the subject of the inquiry. These should be addressed to the Secretary of the Committee, 1/3 St. Andrew's Place, Regent's Park, London, N.W.1, to reach him before December 31.

## University News: Queen's University, Belfast

DR. H. B. HENBEST, reader in organic chemistry at King's College, London, has been appointed to the chair of organic chemistry at the Queen's University, Belfast, in succession to Prof. R. A. Raphael.

### London

DR. P. T. MATTHEWS, lecturer in the University of Birmingham, has been appointed to the University readership in applied mathematics tenable at the Imperial College of Science and Technology.

### Sheffield

THE followi ~ appointments in the University of Sheffield are announced: P. H. Blundell, as director of the Electronic Computation Laboratory; Dr. B. Stevens, as lecturer in physical chemistry; M. S. Clements, as lecturer in civil engineering; Dr. Russell Brown, as lecturer in electrical engineering. The following appointments to fellowships have also been made: C. J. Edmonds, to the Boots research fellowship for work in the Department of Pharmacology and Therapeutics; D. J. Williams, to the C. H. Desch research fellowship in metallurgy; and P. L. Chambers, to the John Stokes research fellowship to be held in the Department of Physiology.

## Announcements

MR. E. J. MANN, formerly assistant director of the Commonwealth Bureau of Dairy Science and Technology, has been appointed director of the Bureau. He succeeds Mr. A. W. Marsden, who left the Bureau in July 1957 in order to take up his new appointment as organizing secretary of the Fifteenth International Dairy Congress.

THE Reith Lectures for 1957, entitled "Russia, the Atom and the West", will be given by George F. Kennan, professor of history at the Institute for Advanced Study in Princeton and leading American historian of Soviet Russia. This is the first time the Reith Lectures have dealt with the immediate problems of international relations. The lectures will be broadcast on successive Sunday evenings in the B.B.C. Home Service at 9.15 p.m. The first is on November 10.

A BANQUET to celebrate the golden jubilee of the Royal College of Surgeons of England will be held at Lincoln's Inn Fields, W.C.2, on November 12. H.R.H. the Duke of Edinburgh will be present.

A MEETING, organized jointly by the Acoustics Group of the Physical Society and the North-Eastern Branch of the Institute of Physics, is to be held at Newcastle on Tyne during November 15–16 on the subject of "Flow Noise". Further information can be obtained from the Secretary, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

A SYMPOSIUM on "Vacancies and other Point Defects in Metals and Alloys" is being arranged by the Metals Physics Committee of the Institute of Metals to be held at Harwell during December 9–10. Further information can be obtained from the Secretary, Institute of Metals, 17 Belgrave Square, London, S.W.1.

A TWO-DAY meeting on water pollution in the iron and steel industry will be held by the Iron and Steel Engineers Group at Church House, Westminster, London, S.W.1, during December 11–12. The meeting will be open to all those interested whether they are members of the Iron and Steel Institute or the Iron and Steel Engineers Group or not.

A CONFERENCE on "The Band Theory of Metals and the Structure of the Fermi Surface", organized by the Physical Society, will be held at the Imperial College of Science and Technology, London, during December 19–20. There will be four sessions on: theoretical aspects of the band structure of metals; experimental results related to band structure; experimental examination of the Fermi surface; and the Fermi surface and related topics. There will be a limited amount of accommodation available. Non-members may attend the conference on payment of a fee of one guinea. All inquiries should be addressed to the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7, marked for the attention of Miss Miles.

A CONFERENCE, organized by the Institute of Fuel, on "Science in the Use of Coal" will be held in Sheffield during April 15–17, 1958. There will be six sessions: "Physics and Chemistry of Coal"; "Coal Preparation and Breakage"; "Coal Carbonization"; "Combustion and Gasification"; "Reactivity of Cokes and Chars"; "General Discussion". Brief opening surveys will be presented at the first five sessions. Advance copies of these will be supplied to authors who intend to submit communications. Further information can be obtained from the Secretary, Institute of Fuel, 18 Devonshire Street, Portland Place, London, W.1.

ERRATUM. Dr. K. Mendelssohn writes: "My attention has been directed to the fact that in my article on the Russian Low Temperature Conference (*Nature*, 180, 460; 1957) I omitted to mention that two observers, one from Poland and one from Hungary, had also attended. They were not low temperature physicists but hoped to initiate this type of work in their respective countries. Omitting their presence from the list of foreign visitors may give rise to the misinterpretation that I have considered their countries as parts of the U.S.S.R.".

# INTERNATIONAL CO-OPERATION IN MARINE RESEARCH

MARINE science is growing in usefulness and begins to attract more support from international as well as national authorities.

Unesco initiated a Marine Sciences Programme in 1955 with the establishment of an International Advisory Committee on Marine Sciences chosen from countries in all parts of the world to represent all aspects of the subject. The main object of the programme is to cultivate interest in the oceans, particularly in countries where scientists are not being very active about them, and while this work takes shape limited funds are available from time to time to stimulate international or regional co-operation in work likely to increase world interest and to make the early stages of the work more effective.

The advisory committee tries to hold its meetings in countries where there is a small nucleus of marine scientists ready to take advantage of the influx to discuss work being done in the region, and symposia on regional problems are arranged. One of the most direct methods of achieving the educational and cultural aims is to provide visiting lecturers and travelling fellowships. Short courses have been held at suitable laboratories, for example, a three-weeks course in planktology at Nhatrang in 1956, and more ambitious schemes are being planned.

While these plans are taking shape, grants have been made to a number of symposia arranged by organizations such as the Association of Physical Oceanography and the International Council for the Exploration of the Sea on the most prominent topics of the day. They have included symposia on ocean circulation and on the measurement of primary productivity in the ocean. The Association of Physical Oceanography has been granted a useful sum to facilitate participation by Norway in a joint operation with the United Kingdom and United States to develop and use techniques for measuring deep currents in mid-Atlantic Ocean. Another sum is being used to help scientists from Australia, New Zealand and New Caledonia to lay the foundations for a study of the surface currents and water circulation in the south-east Pacific Ocean and the Tasman Sea.

Unesco is also organizing practical study of the feasibility of joint ownership of research vessels by groups of countries. This seems to be the only answer to the growing cost of maintaining ocean-going research ships. Sooner or later it must be done, and the possibility of a trial venture in the Indian Ocean is being explored. Further tasks have been the assembly of advice and material from competent organizations and scientists on the oceanographic problems bearing on sea and ocean disposal of atomic wastes, and a similar assessment of the scientific considerations relating to international laws designed to govern continental shelves.

Unesco is an ideal organization for cultivating enthusiasm in subjects of educational and cultural value, and the liberal study of the oceans is as good a discipline as any. There is no better field in which to promote mixing of ideas and free exchange of views, and the headquarters and area offices of Unesco know how to go about it.

The International Council of Scientific Unions, to which Unesco makes a large annual grant, is just as suitable for advancing research at higher levels. It encourages and co-ordinates activities of the international scientific unions and furthers common effort in subjects inadequately covered by existing arrangements.

The International Council of Scientific Unions has responded to the needs of marine science by setting up a Special Committee on Oceanic Research, which met for the first time in Woods Hole Oceanographic Institution, Woods Hole, Mass., during August 28–30. The following were present: Dr. A. Bruun (Denmark), Dr. G. Böhnecke (Germany), Cdr. R. A. Capurro (Argentina), Dr. G. E. R. Deacon (United Kingdom), Dr. M. N. Hill (United Kingdom), Dr. C. O'D. Iselin (United States), Dr. N. B. Marshall (United Kingdom), Dr. Y. Miyake (Japan), Prof. H. Mosby (Norway), Dr. N. W. Rakestraw (United States), Dr. R. Revelle (United States), Prof. Steemann Nielsen (Denmark) and Prof. L. Zenkevitch (U.S.S.R.). Prof. Y. Le Grand (France) and Dr. N. K. Pannikar (India) were unable to attend. Two days were spent discussing outstanding problems in all aspects of the subject with the purpose of finding which could be most helped by planned co-operation between many countries. Although the Committee sometimes regretted the absence of one specialist or another, it was adequate, with some timely reinforcement from the Woods Hole Laboratory and its wealth of visiting scientists, to make the occasion a memorable one.

The outcome was a general agreement that there is a real need for international collaboration in studying the deep oceans. Theoretical studies and the development of new techniques are likely to succeed well enough in individual laboratories and in co-operative effort between major institutions bordering on common ocean areas and having joint interests, but the task of sending expeditions to distant parts of the ocean, even to areas which promise the best conditions for studying basic problems, becomes increasingly difficult for any country. We know something of every ocean, but there are large fairly blank areas where modern ideas and methods are not likely to be applied until the cost and effort are widely shared.

Among the new techniques which should be used are: (1) measurement of salinity of the deep and bottom waters with the new order of precision made possible by electrical conductivity measurements; (2) direct measurement of the deep currents with free-drifting floats or moored current meters; (3) use of the distribution of naturally occurring radioactive substances as indicators of circulation and mixing; (4) quantitative biological, chemical and physical studies of the sediments; (5) measurement of heat flow from the earth to the water; (6) studies of the carbon dioxide content and the exchanges between ocean and atmosphere. The well-tried methods so far used in biological studies must also be supplemented by recent photographic and acoustic techniques. These and other advances that can be expected during the next few years require the use of ships fitted for deep-sea exploration. This is the most expensive kind of oceanographic research, and an adequate programme is beyond the resources of any one country.

The Special Committee on Oceanic Research judged that the best way to start is to devote the next two or three years to organized attempts by working groups to review the special problems that will be

tackled, to widen the acceptance and use of promising techniques and to fill gaps so far as possible. By the end of this preparatory period it should be possible to gather sufficient ship-time and funds together to make a combined assault on one of the least-known and most promising areas. The Indian Ocean was thought to fill this requirement. Its submarine topography and water circulation are not very well known; the complete reversal of wind in two halves of the year affords a unique opportunity for studying how quickly the currents and water layers respond to wind changes, and there is much biological and geological work to be done.

Such a programme cannot be carried out without enthusiastic support of existing national and international organizations, and fairly immediate practical aims must be urged as well as long-term need for better understanding of the oceans. One growing need is for a better appreciation of the effect of using the oceans as a receptacle for the waste products of industry. Even now we need to know what effects the water circulation and the migrations of marine animals are likely to have on the transport of radioactive material deposited in the ocean. We no longer look on the oceans as infinite and readily available sources of food, but we are more and more conscious that better understanding of their physics and biology will be a great help to the successful use of their tapped and untapped resources. The study of climate and weather has also advanced to the stage where it begins to need more understanding of the circulation of heat in the oceans and their interchanges with the atmosphere.

The idea of making a start in the Indian Ocean is likely to receive the approval of most international authorities interested in the oceans. Unesco will have opportunities to arrange the training of scientists from countries around the Indian Ocean, and to make the possibilities known to more countries. The Food and Agriculture Organization is very interested in the striking fluctuations in the fisheries in the northern part of the Ocean, and their effect on the local populations. The scientific unions will recognize the value of new and widespread measurements to basic as well as to the regional problems.

The idea will not go unchallenged. There are not many oceanographers, and they are not likely to welcome new obligations. It was not easy for oceanography to take part in the International Geophysical Year. The scheme that is gradually being formulated is, however, a reasonable plan, with plenty of encouragement for individual effort and inter-laboratory collaboration, as well as measures for promoting co-operation on a larger scale than can be achieved without special organization. The plan is also arranged to take full advantage of the knowledge and experience of existing organizations such as the scientific unions, which are mainly concerned with basic studies of particular aspects of the subject, and the regional associations such as the International Council for the Exploration of the Sea, the Pacific Science Council, and others, which grow in importance but are primarily concerned with regional problems. One of the fears most expressed is that there is too much overlapping between all the new and old interests, and too many conferences. As the subject grows we must work for some unification, but it is only fair to admit that there has been so far no forum in which specialists in all aspects of the subject meet together, and we already see growing enthusiasm and sharing of responsibilities. G. E. R. DEACON

# THE TECHNICAL ASSISTANCE BOARD

## REPORT FOR 1956

THE annual report of the Technical Assistance Board for 1956* to the Economic and Social Council of the United Nations records that a higher initial earmarking of funds for the participating organizations and the secretariat—up to 97·3 per cent of the approved programme, compared with only 56 and 71 per cent, respectively, in 1954 and 1955—with consequent smoother implementation of the programme, was possible; also that 93 per cent of the programme was delivered to the centres requesting assistance during the year. Of the 25·3 million dollars expended on field operations during 1956, 18 per cent was for the 2,128 fellowships, including study grants awarded, for which 88 countries served as hosts; 13 per cent on equipment and supplies for training and demonstration; and the remaining 69 per cent to finance the 2,346 experts supplied. These experts were drawn from sixty-seven nationalities, and despite difficulties in recruitment in certain specialized fields, this total is 238 higher than in 1955; the professional standard was maintained at a high average level, although there are indications that the Expanded Programme does not offer conditions of service adequate to attract men and women of the quality desired in the absence of idealistic motives.

Technical assistance was provided in fifty-six sovereign States and in forty-seven dependent territories; but soundly based requests for technical assistance greatly exceed in volume the possibilities of meeting them, and the report suggests that even if increased resources become available it may be wise to concentrate on the neediest countries and territories. Some adjustments in the geographical distribution have already been made: in 1954, Viet-Nam, Cambodia, Laos, Sudan, Tunisia, Morocco and Ghana received technical assistance under the Expanded Programme amounting to 240,000 dollars; in 1956 they received 780,000 dollars, and for 1957 it will be about 1·5 million dollars. In many of the less-developed countries, requests for assistance place increasing emphasis on the development of administrative and technical services. The ability of a country to develop its resources and to take full advantage of technical assistance depends largely on the stage of development of its government and administration, and increasing attention is likely to be given to this aspect as the resources of the programme expand.

The Technical Assistance Board is examining the high proportion of continuing projects—915 out of the 1,334 projects in operation in 1956 were started in 1955 or earlier—with reference to the possibility that the programme as a whole is becoming rigid. The continuing programmes accounted for 85 per cent of the expenditure on the field-programme, but this was largely due to the overlapping of programme years, although there are a few genuine long-term projects. Nevertheless, the chapter on evaluation of the programmes introduced this year is intended to be a regular feature of future annual reports, and it is hoped that governments will co-operate in pro-

* Annual Report of the Technical Assistance Board for 1956. Pp. 244. (New York: United Nations, 1957.)

viding the material on which an effective annual review can be based. The number of pledged contributions again increased: for 1956, seventy-seven countries pledged 28·8 million dollars, and for 1957 some eighty countries have already promised about 30·8 million dollars. Nevertheless, as already noted, the financial resources fall far short of what is required to meet the demand, and financial uncertainty still hampers orderly planning. It would be difficult to over-estimate the gain for the Expanded Programme if the Board and Participating Organizations could reasonably count on the expansion of its resources over the next five years to the 50 million dollars a year envisaged.

In evaluating the programme, the report this year emphasizes the increasing effectiveness of co-ordination between the Expanded Programme and other multilateral and bilateral programmes in the assisted countries, and the recipient countries were also agreed as to the value of the contribution made to their national development, and that had more funds been available the three types of assistance—experts, fellowships and equipment—could have been combined more effectively to produce a better balanced economy. With few exceptions, the international experts proved not only technically competent but able also to acclimatize themselves quickly and to collaborate effectively. Of the 530 fellowship holders in some eighteen countries, all but 6 per cent now occupy positions where their training can be put to effective use; and although many had fairly recently returned, 45 per cent were already occupying positions of greater responsibility. The Board was also satisfied that all the equipment and supplies provided under the Expanded Programme were effectively utilized.

Almost a third of the report, apart from the appendixes, is occupied by accounts of some projects in operation in 1956. Many of these are of real interest to the scientist and technologist, but only a few can be selected to illustrate what is being done. In view of the direct relation between the development of potato blight and the meteorological environment of the growing crops, the Government of Chile requested help from the World Meteorological Organization to apply meteorological science to the control of potato blight in particular and to other problems of agriculture, and an expert from the Meteorological Service of Ireland was assigned to advise the Chilean Government. While the main purpose of the Chilean authorities was to lay the foundations for an advisory service on the application of fungicides, it also sought answers to other questions on the relation between blight and weather conditions and the areas suitable for testing or growing seed potatoes. Partial answers were provided to these questions which can be amplified and confirmed when more complete data on weather and the incidence of disease are available, criteria used in Ireland for detecting and forecasting blight weather proving equally applicable in Chile, and the Chilean authorities are setting up a network of agro-meteorological stations at their agricultural experimental farms.

At the request of the East Africa High Commission a mission of two meteorological experts was appointed to investigate the meteorological factors in the control of the desert locust and advise on the application of meteorological science to that end. Excellent progress is being made in a detailed and critical synoptic analysis of locust events in co-operation with all the meteorological services concerned, as well as in collaboration with the Anti-Locust Research Centre in London. A Unesco mission on arid-zone research at Recife in Brazil has led to many other requests for such assistance, including a geological and hydrogeological study for a dam on the River Paraguay and the creation of a diploma in hydrogeological studies at the Engineering School at Recife. The establishment of a forest research laboratory for the Philippines, assistance in vocational and technical education in Turkey which led to the production of a five-year-plan for the vocational and technical education of men and boys, assistance given to Indian industry in the improvement of efficiency and productivity, the development of civil aviation services in Indonesia, technical as well as legal assistance to civil aviation in Salvador, the eradication of malaria in Mexico and tuberculosis surveys in Africa are other projects briefly described in the report which can only be mentioned.

## THE NUFFIELD FOUNDATION

### REPORT FOR 1956–57

THE wide range of the projects which the Nuffield Foundation supports is once again illustrated by the twelfth report of the Foundation, which covers the year ended March 31, 1957. The introduction to the report reiterates that the Foundation's aim is to assist promising work which for some reason is not attracting support from elsewhere and, after enumerating various purposes which the policy of the Foundation does not allow it to assist, points out that the Foundation subscribes to the view that the pursuit of new knowledge is as much the duty of a university as is the dissemination of existing knowledge. Accordingly, the Foundation does not feel called to assist the everyday investigational work of a university department.

Of the grants for science in the United Kingdom, those for biological research, which totalled £54,545, included two further grants of £725 and £2,500 to Dr. Dorothy Crowfoot Hodgkin's unit in the Laboratory of Chemical Crystallography, Oxford, for work on X-ray analysis of large molecules; £5,000 in support of work in the Department of Zoology, Liverpool, on the initial causes of mucosal damage in patients with peptic ulcer and on the evolution of mimicry in polymorphic butterflies with a view of showing how much the effect of major genes can be modified as a result of the evolution of a new gene-complex by natural selection; a further grant of £14,000 over five years in support of the two units in the Department of Zoology and Comparative Anatomy, Oxford, working on evolution in wild populations, industrial melanism, analysis of the causation of behaviour (with emphasis on sensory perception prior to learning and on motivation), the survival value of various anti-predator devices and adaptive radiation in evolution; £7,400 over three years in support of Prof. H. E. Street's work at the University College of Swansea on the nutrition and metabolism of excised root cultures; and £2,000 over three years to the University of Durham for work on the hatching mechanism of the potato-root eelworm. The grant towards the work on non-specific immunity at the Lister Institute of Preventive Medicine has been renewed for a further five years at the rate of £3,000 a year. Other grants for scientific research

include £1,135 to Dr. N. R. Hanson to enable him to write a book, "The Positron: a Chapter in the History of Ideas", illuminating the interplay of theory and observation at the frontiers of scientific discovery as shown in the discovery of the positive electron, and an additional £2,000 to the Research Laboratory for Archæology, Oxford, towards increases in expenditure during 1956–57.

Of the £125,000 allocated for technology, the largest grant is £3,300 over two years for an investigation—into the effectiveness of existing experiments in removing hindrances to the application of science—which the Science and Industry Committee, formed jointly by the Royal Society of Arts, the British Association and the Nuffield Foundation, now proposes to undertake. Besides a grant of £1,200 over three years towards an investigation into the training of design engineers at the Department of Engineering, Cambridge, another grant of £400 was made to the same Department for a further experimental course to study the application in a different environment of techniques developed for training graduate engineers for junior executive posts and to experiment with a technique of examining the relations within a group of managers, while a grant of £1,000 a year for three years was offered to the Borough Polytechnic for research scholarships in food chemistry.

In the field of medicine, the Foundation, with the help of the Oliver Bird Fund, continued to concentrate its support of research in rheumatism in a few centres where fundamental research is under the direction of men of proved ability. The final results of one long-term chemical trial of cortisone have shown that cortisone is no better than aspirin in the treatment of early rheumatoid arthritis. A grant of £9,595 over three years was offered to the University of London for research on hypnosis by Prof. H. J. Eysenck at the Institute of Psychiatry, and £6,330 over three years for Dr. J. G. L. Williams's investigation at St. Thomas's Hospital Medical School of the possibility of using the measurement of cardiovascular responses in the diagnosis or classification of psychiatric patients and in measuring the efficiency of the therapy they undergo.

A further grant of £1,400 a year over two years was provided for Dr. Honor Smith and her team at the Radcliffe Infirmary, Department of Neurology, Oxford, to study in greater detail the abnormal immunological patterns in disseminated sclerosis, while a grant of £10,000 was made to assist the erection and equipment of a rehabilitation unit for the disabled agricultural worker, consisting of a hostel for twelve patients and a remedial therapy section which provides occupations which the agricultural worker is likely to need. The Foundation is also providing £16,000 to carry the industrial health service being set up at the Central Middlesex Hospital by the North-West Metropolitan Regional Hospital Board through its first three years and has set aside £7,150 over three years in support of Mr. R. H. Hunt Williams's research at the Royal Berkshire Hospital, Reading, on problems of hearing and deafness in early infancy. An offer of £9,000 over three years has been made to the University of Leeds and the United Leeds Hospitals in support of research on problems of screening in diagnostic radiology, including the use of television techniques.

No large grants were made during the year in the social sciences, to which £81,975 was allotted, but special attention is directed to two projects. The first of these is the pilot study being made at Leeds University Library, of how it is used for borrowing by undergraduates and scholars, for which the Foundation has set aside £2,000. It is hoped that something will be learnt of how many titles are required for the undergraduates of a large mixed university and of gaps in the collection, from an examination of loans obtained from other libraries. Some of the material may form the basis of further studies in connexion with the use of the library for research purposes. The second project, which may also lead to further investigation, is into the wilful damage which is being done to social amenities by young people in the new towns. Dr. James Macintosh is in the first place collecting the facts with the ultimate object of suggesting what action might be taken or what further studies are required, and he will also study the methods of education in citizenship of children, adolescents and their parents provided by official and unofficial bodies: the Foundation has allocated £2,350 for the first year of the investigation. A further grant of £3,915 was offered to the Shoreditch project for the revised version of its family service unit to help families which appear to be in danger of breakdown, on condition that the final design of the research is approved by Prof. R. M. Titmus.

The University of Manchester received £2,000 to enable Prof. S. Devons to carry out a pilot experiment with young physicists in part-time university work combined with part-time science teaching at local grammar schools. A grant of £950 to The Queen's University of Belfast was to enable Mrs. J. M. Alexander to continue her study of factors which affect the supply and training of scientists, such as the problem of schoolchildren capable of advanced scientific work, who either leave school early for non-scientific fields or who are directed to arts subjects at an early age, and the difficulties which seem to exist in the full use of women in scientific and technical employment.

The Royal Institute of Public Administration has been assisted in its comparative and critical study of the organization of building construction and maintenance in local authorities with a grant not exceeding £2,250 a year for up to two years. Mr. J. G. G. Wootton's study of the organization and working of the Association of Engineering and Shipbuilding Draughtsmen is being assisted by a grant of £375 over two and a half years, and a grant of £6,000 over three years was made to the University of Leicester in support of an eight-volume agrarian history of England. A brief progress report from the Division for Architectural Studies notes that the team engaged in the study of laboratories has completed its survey into the utilization of space and services and also the studies of daylight conditions in laboratory rooms, made jointly with the Building Research Station; that the first stage of the building programme at the Imperial College of Tropical Agriculture, Trinidad, was designed during 1956; and that the Division is to prepare plans for a small Agricultural Research Council Laboratory at Cambridge.

A grant of £3,000 a year for three years was offered in support of Mr. P. Townsend's study at the London School of Economics and Political Science of the institutional care of old people, and a further £9,000 has been set aside for Prof. K. J. Franklin's work on the ageing effects of ionizing radiation at St. Bartholomew's Hospital Medical College, in continuation of his studies on the physiology of ageing.

The grant to the University of Bristol for field studies on the employment of elderly workers has been renewed for two years at the rate of £3,700 a year.

Among grants for the Commonwealth overseas, which totalled £32,741, may be mentioned a further £800 to the Departments of Anthropology and Anatomy, University of Sydney, in support of the expedition to the Western Highlands of New Guinea; £20,000 over three years to the Central Pedagogical Institute, Allahabad, in support of its work in teaching English; a further £3,500 to enable the Smuts Archive Trust to complete its work; £3,600 over two years to the University of the Orange Free State in support of research on soil organic matter; £1,800 over three years to the Plant Physiological Research Institute, University of Pretoria, for research on amino-acid metabolism and other aspects of the assimilation of nitrogen; £2,450 over three years to the University College of the West Indies for marine biological research; and £8,000 to the Uganda Foundation for the Blind for capital expenditure and maintenance costs over two years of a scheme for the training and employment of the rural blind.

Travel grants included one to enable Dr. L. Guttmann to visit cities in six of the Australian States to advise on the development of spinal centres and on facilities to be provided for vocational training of the physically handicapped.

Only one medical fellowship was awarded in 1956, but the dental fellowships and scholarships scheme continued to attract a high standard of applicant and three fellowships and two scholarships were awarded. The schemes for biological and sociological awards continued unchanged. One bursary in biology was given and one scholarship in sociology. The regulations for the Royal Society and Nuffield Foundation Commonwealth Bursaries have been slightly altered to make it clear that applicants should hold salaried posts to which they will return and that they will draw their salary while away. The Foundation arranged with the Indian and Pakistan Governments to provide two travelling fellowships annually from each country to members of the administrative class of the Civil Service for study in the United Kingdom, but otherwise policy for awards from the Commonwealth countries was unchanged. The scheme for overseas farmers is to be enlarged by an additional award, and with the National Research Council of Canada, the Foundation is to provide travel grants to enable senior lecturers or professors to visit the smaller Canadian universities.

## THE DEFENCE STANDARDS LABORATORIES, AUSTRALIA

### ANNUAL REPORT

THE broad function of the Defence Standards Laboratories in Australia is the application of scientific knowledge and research within the fields of chemistry, physics, metallurgy and engineering to the problems arising in the design, development, manufacture, inspection, storage and use of defence material. In addition, as the name of the establishment indicates, it is concerned with the maintenance of standards of measurement and of quality, its own being based on the national standards held by the National Standards Laboratory, Sydney, and on the specifications prepared and issued by the Standards Association of Australia. In the annual report of the Laboratories for the year ended June 30, 1956*, an account is given of the general activities of the establishment and of the more important projects and investigations either completed, or in which significant progress was made during the period under review.

Recruitment during the year both in the professional and other staff was not sufficient to maintain strength, and the total staff at Maribyrnong, Victoria, and the two inter-State branches (Alexandria, New South Wales, and Finsbury, South Australia) decreased from 594 to 577, reflecting the general shortage of scientific and technical man-power in Australia. The organization consists of a chief superintendent, Mr. A. E. Dawkins; deputy chief superintendent, Dr. F. A. Fox, appointed in February 1956; and four divisions—materials and explosives, protective chemistry, metallurgy and engineering, and physics.

In the Chemistry Division work was done on the analysis of gases by interference refractometry; the determination of small quantities (of the order of two micrograms) of acetone in air; the determination of oxygen and nitrogen in metals and alloys and the recrystallization of barium sulphate. New forms of titanium esters were developed for use in paints, and standard soils for the testing of dishwashing detergents and for metal-cleaning preparations were investigated. In biochemistry a study was made of the organophosphorus compounds which are used as insecticides and plasticizers and in medicine.

The Metallurgy Division was mainly concerned with the production and processing of pure chromium and chromium alloys. Investigations of their properties and structure were largely confined to attempts to elucidate the nature and cause of the lack of ductility of the chromium-base alloys at room temperature. A study was commenced of the embrittlement of the metastable beta-phase alloys of titanium. Other investigations included the lost wax process, corrosion problems associated with iron and steel in cooling waters, cadmium plating, and lead in chromic acid.

The diverse activities of the Physics Division covered the fields of chemical physics, radiological physics, metrology and temperature measurement. Improvements were made to the microwave spectroscope and nuclear spectrometer parts were constructed and tested. The new technique of microwave observation of detonation announced in the 1954–55 annual report was further improved. An apparatus was devised which enables the thermal conductivity of gases and vapours to be determined from the equilibrium temperature attained by a platinum spiral immersed in the fluid, and measurements were made on pure gases and on binary mixtures. In connexion with the study of the accuracy and reproducibility of temperature measurement at the triple point of water, the performance of the Laboratories' Smith resistance thermometry bridge was improved by the use of a stable decade resistor for calibration purposes. A new type of multi-cell inert dry battery composed of ordinary cells made inert by dehydration under heat and vacuum was developed and this is discussed in some detail in the annual report.

Various other miscellaneous investigations included research on xerography; the effects of climates in different parts of Australia on the durability of paint

* Annual Report of the Defence Standards Laboratories for the year ended 30th June, 1956. Pp. iv+44. (Maribyrnong, Victoria: Defence Standards Laboratories, 1957.)

films; the priming of wood; the weathering of textiles; viscometry; and mathematical studies. The report concludes with lists of the various personnel and their status, the numerous publications by members of the staff of the Laboratories and the names of the various governmental and other committees on which the establishment has been represented.

## GEOGRAPHY IN JAPAN

THE International Geographical Union normally sponsors a World Congress every four years, the last two being held at Rio de Janeiro (1956) and Washington (1952). Although much scientific work is being carried on continually through a series of a dozen Commissions, the Executive tried the experiment of holding a Regional Conference of more limited scope than a main Congress, and with a definite field of work. Following the success of the first such Regional Conference on Africa at Makerere in 1955, the Executive gave its support to the proposal of the Japanese National Geographical Committee under the chairmanship of Prof. Fumio Tada (University of Tokyo) that it should organize a Regional Conference in Japan. The Conference was held during August 28–September 3, with the support of the Science Council of Japan and of numerous universities and municipalities at Tokyo and Nara. The programme, which also included a symposium on South-East Asia and a range of papers in nine sections, centred on the problems of monsoon Asia in general, and Japan in particular, and afforded to the eighty delegates from overseas an opportunity of seeing and appreciating the work of Japanese geographers.

The Conference was preceded by two long excursions, to Hokkaido and northern Honshu, and followed by three others to central and western Japan. The substantial guide books prepared for these excursions were arranged to form a complete regional geography of Japan which, together with a summary volume, afforded the first geographical description of Japan in English written entirely by Japanese authors. Although summaries of original papers in Japanese have long been added in a Western European language (in recent years usually in English), the main work of Japanese geographers has remained little known to Western workers. A comprehensive exhibition of the maps published officially by the Geographical Survey Institute under the direction of Akira Watanabe (one of the secretaries of the Conference) showed examples not only of the large range of geographical and geological maps, but also of many specialized cartographical experiments which have scarcely been seen outside Japan, including a number still in manuscript. The delicacy of old Japanese art is reflected in the many beautiful examples of modern map production and printing. In a country where pressure of population on limited land resources is so extreme that each acre of cultivated land must support six or seven persons in food, it is natural that special attention should be paid to the accurate portrayal of land forms and land use.

In particular, Japan has accepted the principle that to map accurately the existing use or non-use of land is an essential prelude both to understanding the present position and to planning for the future. By mid-1957 no less than 300 sheets on the scale of 1 : 50,000 of the land use map had been completed —roughly a third of the whole country excluding Hokkaido. This work is financed in the main by the prefectural governments, and the maps, undoubtedly the finest and most detailed produced anywhere in the world, have not been placed on public sale. The classification of land use follows the scheme advocated by the World Land Use Survey and Commission of the International Geographical Union, but with many refinements to meet local conditions. In a country primarily dependent upon rice, there is an important distinction between paddy lands and land for other crops; the determining factor both in this case and in other forms of land use is often degree of slope. Accordingly, experimental maps have been produced, also on the scale of 1 : 50,000, of slope, land-form and valley-density. The slope map displays seven categories of slopes ranging from more than 40 deg. to less than 3 deg. The valley-density maps shows valleys revealed by air photographs to be suffering from gullying and degradation, and records the number of such valleys per square kilometre. The land-form classification map is an ambitious attempt, combining a classification based primarily on different types of hill lands, uplands and terraces and lowlands with a symbolic representation of surface geology and a scheme of minor physiographical regions. An explanation published (in English) in the *Bulletin* of the Institute in March 1955 urges that such work must precede soil surveys as understood in other countries and of which Japan has published also one experimental sheet (1953). The dependence of Japan for protein on fish has led to much attention being given to the mapping of details of the sea floor and of marine deposits around the islands. The numerous other fields of original study were well shown in the 130 papers contributed to the nine working sections.

A volume of abstracts was printed in advance, and it is planned to publish a comprehensive report of the Conference. Among the foreign participants were the president of the International Geographical Union, Prof. Hans Ahlmann (Sweden), the two immediate past-presidents, Prof. L. Dudley Stamp (United Kingdom) and Prof. G. B. Cressey (United States), the secretary-treasurer, Prof. Hans H. Boesch (Switzerland), and the past vice-president, Prof. G. Kuriyan (India). L. DUDLEY STAMP

## MAKING AND BREAKING POLYMER MOLECULES

RECENT advances in polymer chemistry of especial current interest were reviewed under the title "Making and Breaking Polymer Molecules" at the second session of Section B (Chemistry) of the British Association held in Dublin on September 9. At the invitation of Dr. J. W. Cook, president of the Section, Prof. C. Kemball took the chair and introduced the following contributions: "The Mechanico-chemistry of Polymers", by Dr. L. Bateman (British Rubber Producers' Research Association); "Stereospecific Polymerizations", by Prof. H. F. Mark (Polytechnic Institute of Brooklyn); "Synthetic Polypeptides as Models for Natural Proteins", by Dr. C. H. Bamford (Courtaulds, Ltd., Maidenhead); and "Plastics for Use; Designing Molecules for Particular Purposes", by Dr. C. W. Bunn (Imperial Chemical Industries, Plastics Division).

In some introductory remarks, Dr. Bateman noted that the present familiarity with rubbers, plastics, and fibres and with the essential part they play in everyday life tends to obscure the fact that they are largely products of the twentieth century and quite considerably of the past twenty years. Rubber production, for example, increased from 29,000 tons (all natural) in 1900 to 2,900,000 tons (35 per cent synthetic) in 1955, and rayon showed a still greater proportionate increase (from 1,000 to 2,200,000 tons). Even wool, which as an age-old natural fibre might be regarded as an exception to that generalization, increased in usage from 740,000 to 2,200,000 tons in the period stated. Polyvinyl chloride and nylon, two examples of wholly synthetic materials, were scarcely known in 1935 but were produced to the extent of 630,000 and 113,000 tons respectively in 1955. The scientific basis of the remarkable growth thus illustrated is two-fold: increasing mastery of the transformation of simple compounds into large and complex molecules similar to those of natural origin, and more efficient and extensive adaptation of these polymeric substances, natural and synthetic, to practical purposes. The overall result has been less the replacement of the natural by the synthetic materials, as is often supposed, than mutual augmentation to satisfy a rapidly expanding world demand.

Turning to the main subject of his address, Dr. Bateman pointed out that solid polymers are invariably subject to mechanical treatment during their processing from the raw state into finished products. Grinding, mixing, and extruding typify such treatments, which are generally looked upon as purely utilitarian procedures of little or no chemical significance. However, studies of the mastication of rubber —a basic process in the rubber industry—have recently shown that chemical reactions similar to types encountered conventionally are involved. A new branch of polymer chemistry—the mechanicochemistry of polymers—can be recognized, with many theoretical and practical ramifications. Common mechanical treatments of polymers can be looked at afresh and their purpose and practice more critically appraised, and the making and modifying of polymers can be approached in an entirely new way.

The breakdown of rubber on mastication normally requires the presence of oxygen and is peculiar in proceeding more readily at temperatures both above and below about 110° C. W. F. Watson first clearly recognized that this behaviour is due to two distinct mechanisms of breakdown. One mechanism, dominant above about 110° C., involves direct interaction of oxygen with the rubber, which is known to take place at these temperatures and to lead to molecular scission; the other, dominant at lower temperatures, is a mechanically promoted reaction in which the primary act is the literal tearing apart of polymer molecules into free radicals, the oxygen participating afterwards to prevent recombination of these fragments. Distinctive of this second mechanism is the negative temperature coefficient, which arises from the increase in bulk viscosity as the rubber is cooled, causing the applied force to be utilized more in shearing molecules than in merely displacing them.

This basic picture enables other diverse features of the mastication process to be correlated, and also suggests possibilities for utilizing mechanically generated free radicals for synthetic purposes. Thus, if two polymers are suitably masticated together then cross-combination of the radical fragments so formed can give a block co-polymer. Similar products can be obtained by masticating a polymer with a polymerizable monomer, the free radicals generated from the former initiating polymerization of the latter. This reaction is readily realized in practice and is extremely versatile. Monomers of different chemical and physical type can be employed with a variety of base polymers—plastics, polycondensates such as nylon, and natural carbohydrate and protein polymers can be used as well as rubbers. The reaction conditions are very simple—the reactants have not to be brought into a solution or emulsion, no catalyst or other ingredients need to be added, and no recovery procedure is required to isolate the product. Provided the base polymer can be suitably sheared—and this is the critical factor—high conversions of many monomers can be obtained in the space of minutes at room temperature. A demonstration of such a reaction was given on a laboratory masticating machine specially designed for this purpose.

Prof. Mark began his address by observing that the plastics industry has developed on the basis of an understanding of addition polymerization, which proceeds by a chain process comprising three stages: an initiation step in which a vinyl monomer is converted into a highly reactive intermediate; a propagation step in which the polymer chain is extensively built up from the primary intermediate, and a termination step in which polymer growth is stopped by conversion of active intermediates into inactive molecules. Control of the overall reaction has hitherto been restricted, however, to the first and last of these steps, with two important consequences. First, certain simple vinyl compounds such as ethylene and its alkyl derivatives have either not been polymerized or have only responded to abnormally vigorous conditions; secondly, the addition of each monomer unit to the growing polymer chain has proceeded randomly with little regard to any structural or stereochemical pattern.

It might be expected *a priori* that control of the propagation step would require the reactive locus of the growing polymer, whether free radical or ionic, to be complexed so as to confer more highly selective reactivity both dynamically and stereochemically. The new class of polymerization catalysts, recently discovered by Ziegler and extensively exploited by Natta and others, would appear to function essentially in this manner.

These last outstandingly important developments stem from Ziegler's observations that a very limited degree of polymerization of ethylene at room temperature and pressure induced by certain metal alkyls can be remarkably enhanced by certain metal halides, notably of titanium, to yield a polyethylene of high molecular weight. Not only are the reaction conditions so different from the high-pressure process developed by Imperial Chemical Industries, but the product also differs from commercial polythene in being harder and of considerably higher softening point—now known to be due to its more regular linear structure.

The high activity of Ziegler catalysts and the stereochemical control they exert on polymer synthesis are strikingly apparent with substituted ethylenes. Alkylethylenes hitherto resistant to extensive polymerization have been converted into high polymers, in many cases with the substituent groups

strictly oriented with respect to each other along the polymethylene chain. Several such hydrocarbon polymers, in which the molecular configuration results in compact structures showing high crystallinity, have melting points above 300° C. Butadiene and isoprene also polymerize easily under similar conditions, and by subtle changes in catalyst composition 1 : 2- and 1 : 4- attachment can be selectively promoted, in the latter case to give either the *cis* or *trans* forms. The different isomers have been isolated in fairly high states of purity, the essential constituents of natural rubber and gutta-percha (*cis*- and *trans*-polyisoprenes) being synthesized in this way.

Prof. Mark concluded by referring to the immense impact of this work. Industry had responded vigorously to the potentialities of using some of the cheapest and most abundant organic compounds as sources of polymers, with technical qualities promising to make them formidable competitors to established materials. Large-scale plants for producing some of these new polymers are already on the point of coming into operation. At the same time, the singular achievement of effecting polymerization with a stereospecificity comparable to natural processes has greatly stimulated further research. New types of stereospecific catalysts are being discovered and their range of applicability steadily widened.

In the third paper, Dr. Bamford first explained that the complexity in number and type of the amino-acid units in proteins not only makes it extremely difficult to determine the details of protein structure—so difficult in fact that this has only been achieved for one relatively simple protein, insulin—but impedes correlation of the properties of proteins with specific molecular features. For this latter purpose, synthetic polypeptides derived from one amino-acid are valuable model compounds, since they simulate proteins in essential structural and functional character and yet possess polymeric symmetry which permits various physical measurements to be more decisively interpreted.

After referring to the preparation of high-molecular weight polypeptides by polycondensation of *N*-carboxy-α-amino-acid anhydrides, Dr. Bamford went on to describe their main structural features and especially how these had been investigated by modern physical techniques.

Polypeptides synthesized from single amino-acids such as L-alanine and γ-methyl-L-glutamate behave like some proteins (such as hair keratin) in existing in two inter-convertible forms. In the α-form the molecular chains are folded and coiled into a helix which models show to form a compact, closely packed structure. In the other (β) form, the molecules are extended linearly with the chain atoms forming a nearly planar zig-zag. These two forms give different X-ray diffraction patterns, from which, for example, the dimensions of the helix and the number of amino-acid units per turn can be determined. Detailed structural information has also been obtained by the use of polarized infra-red spectroscopy, which permits the directions of certain bonds in the molecule to be ascertained with respect to the molecular axis. In the α-form of polypeptides the C=O and N—H bonds are found to be parallel, and in the β-form to be perpendicular, to the axis. It can therefore be deduced that an important, indeed essential, feature of the helical structure is a series of hydrogen-bonding 'struts' between groups on neighbouring turns of the helix. In the β-form, however, hydrogen bonding occurs between imino and carbonyl groups in different molecules. This difference of *intra*- and *inter*-molecular bonding is understandably reflected in physicochemical behaviour, as was demonstrated in a simple experiment. The α-form of a polypeptide was rapidly swollen and eventually dissolved by benzene, which had little effect on the β-form, the macrostructure of which is preserved by the extensive polar network. The denaturation and insolubilization of proteins are accompanied by a partial transformation of folded into extended chains, and the nature of this phenomenon has been clarified by work with the synthetic polymers. Silk provides a striking example ; a cast film of silk fibroin in the molecularly folded form was shown to be readily soluble in water, whereas the ordinary (β) form is, of course, insoluble. An example of a polypeptide which 'denatures' on heating in water (poly-DL-alanine) was also demonstrated.

The study of chain configurations in solution by optical rotation measurements was next described. This technique depends on the fact that a helical polypeptide chain itself gives rise to optical activity which may be reinforced or opposed by asymmetric carbon atoms present, and has already given interesting information about the interaction of polypeptides and proteins with solvents of different types.

Finally, the 'kinetic chain effect', in which a polypeptide appears to simulate enzyme action, was mentioned ; this raises the possibility that polypeptides may be useful models for kinetic as well as structural studies.

In presenting the final paper, Dr. Bunn said he wished to emphasize that all the important synthetic polymers so far produced had been discovered by accident or by acute empiricism rather than design, and this approach would certainly continue as a major path of progress. However, the principle of trial and error is becoming more laborious and expensive to apply comprehensively as the possibilities for synthesis continue to multiply, and rational guidance on how to make polymers of given properties will play an increasing part in deciding the main lines to follow. To a considerable extent this is happening to-day, and many qualities of a new polymer can be predicted fairly precisely.

A fundamental difficulty in designing a polymer for a given application is that not one single property is involved, but a number of interdependent properties some of which are mutually antagonistic. The problem, therefore, is to select the most advantageous balance of properties, and this is not easy to do *a priori*, first because the resultant effect of properties considered singly is complex and secondly because the conditions of service may not be directly related to measurable properties of the material.

The bulk properties of polymers may be considered in terms of three fundamental factors : (1) intermolecular interaction ; (2) molecular flexibility ; and (3) crystallization. The influence of the first is well known qualitatively : in non-polar substances such as hydrocarbons, intermolecular attraction is weak, the molecules can readily move past one another, and such polymers will be soft and prone to flow on deformation ; as polar groups which give rise to stronger attractive forces (for example, OH, Cl, $CO_2R$, CN) are introduced, so the polymer will become harder and more rigid. The second factor is associ-

ated with the ease of rotation of segments of the molecule about bonds in the chain. This is partly controlled by steric effects, and partly by more deep-seated effects associated with bonding electrons. Exactly how these determine molecular flexibility is still uncertain, but it is now recognized which groupings confer flexibility and which rigidity. An interesting feature is that certain unsaturated hydrocarbon polymers (*cis*-polybutadiene and natural rubber) are more rubbery than a simple saturated hydrocarbon such as polyethylene, despite the fact that rotation about double bonds is highly restricted and might be expected to increase stiffness. This apparent anomaly reflects, however, the extra flexibility of C—C bonds adjacent to double bonds which more than compensates for the rigidity of the latter. The third factor, crystallization, depends on the detailed nature and regularity of polymer structure and also on physical conditions. No high polymer is wholly crystalline, but certain fibres are nearly so; natural rubber, which is amorphous when unextended, owes its strength to the considerable degree of crystallization which develops on stretching to breaking point. Crystallization is a particular and powerful form of intermolecular interaction and therefore parallels the first factor considered in producing stiffness and hardness and especially strength. It is important to remember that all these factors are dependent upon temperature—as must be borne in mind in any classification of a substance as a rubber, plastic, or fibre. Working conditions 100 deg. C. hotter or cooler than conventional temperatures call for major changes in the usual designations.

Dr. Bunn then proceeded to illustrate how knowledge of this kind can be applied and how variations in the above factors can be traced systematically. Some effects of modifying linear chains with 'branches', of cross-linking, and of co-polymerizing different monomers in different proportions were described. Attention was directed to the 'non-additivity' of the properties of co-polymers with respect to the individual components owing to the complex interplay of the structural factors. This is apparent even in the simplest hydrocarbon systems, where a co-polymer of ethylene and propylene, being non-crystalline, is a soft, rubbery material very different from crystalline polyethylene and polypropylene, which are quite hard and rigid plastics.

L. Bateman

## PSYCHOLOGICAL AND OCCUPATIONAL ASPECTS OF AGEING

THE aim of the symposium on ageing arranged at the Dublin meeting of the British Association by Section J (Psychology) on September 5 was to present a sample of the work being done in Great Britain by psychologists and sociologists. Prof. L. S. Hearnshaw (professor of psychology in the University of Liverpool and honorary director of the Medical Research Council group for research on occupational aspects of ageing) was in the chair, and in his introductory remarks gave a brief historical sketch of the development of research into the psychology of ageing in Great Britain, and an outline of the work in progress at the Medical Research Council group at Liverpool. Prof. Hearnshaw referred to the presidential address, delivered to Section J by Dr. Wynn Jones at the Norwich meeting of the British Association in 1935, on "Personality and Age", which was the first contribution to the subject by a psychologist in Britain; to the work of the Nuffield Foundation; and in particular to that of the Cambridge unit directed by Mr. A. T. Welford during 1946–56. The rising interest in ageing was a natural outcome of the changing age-structure of the population. Not only is the number of persons over sixty-five increasing, but the proportion of the working force between fifty and sixty years of age is also rising. Research must be directed, therefore, not only to the study of old age, but also to the process of ageing from middle life onwards.

Prof. Hearnshaw concluded with a brief progress report on the main lines of work of the Medical Research Council group in Liverpool, which is concerning itself with three matters in the first instance. First, it is attempting to get reliable information, which at present, surprisingly, does not seem to exist, on changes in the main sensory modalities with age. Work is at present in progress on hearing. It is hoped to establish norms of deterioration with age, and to throw light on the effects of such deterioration for general psychological and occupational adjustment. Secondly, the group is concerning itself with those problems included under the general heading of 'rigidity'. There is a certain amount of miscellaneous evidence, partly anecdotal, on the increasing rigidity and lack of flexibility in the ageing person; but the psychological processes remain obscure, and their elucidation seems to be of both theoretical and practical importance. Thirdly, the group is concerned with industrial studies of ageing with especial reference to the attitudes of the ageing person himself and of others towards him.

D. B. Bromley (Liverpool) followed, with an account of his investigations on the effects of age on intellectual processes. Lehmann in the United States has demonstrated that the peak years for creative intellectual output are in the age-range 30–35, that thereafter output decreases faster for quality than for quantity, and that very high-grade intellectual achievement falls most rapidly of all. In Bromley's experiments various tests of intellectual performance were administered to 256 subjects, ranging in age from the twenties to the eighties and forming three matched age-groups with mean ages of approximately 27, 47 and 67 years, respectively. The results were broadly in agreement with Lehmann's conclusions. High-grade intellectual output appears to decline with age, unlike low-grade output (namely, illogical, bizarre or other types of erroneous response), which shows a relative increase. Not only do older people tend to have fewer good ideas, but they also show a diminution of critical capacity and are less able to judge the value of the ideas they do have. Though capable of reproducing acquired knowledge and skills fairly satisfactorily, the older person is inferior in tasks involving new learning, speed of response, and complex material. There is also a decline in 'incidental memory' or 'latent learning', that is, memory for details incidental to and not required by the main task in hand. Bromley suggested that this finding, if valid, might be of some significance, since a great many advances in scientific research had been made as a result of incidental observations. One of the

reasons why older people make fewer outstanding and original contributions to intellectual achievement may be that their capacity for benefiting from incidental experiences is reduced.

Bromley ended his paper with a word of caution. He pointed out that the conclusions reached by psychologists investigating adult intelligence are at best only poor approximations; the tests used are not wholly reliable nor altogether suitable for the purposes to which they have been put; and theories and explanations at present scarcely more than guesswork. Nor are the practical consequences of the findings at all easy to appraise.

The second speaker, S. Griew (Bristol), reported on some recent findings on age and industrial performance obtained by the Unit for Research on Employment of Older Workers, a team which is financed by the Nuffield Foundation. Analysis of the age structure of the workers in a number of light engineering firms showed a remarkable degree of agreement between the rankings of jobs by age, both between different firms and between two different periods (1947 and 1955) in the same firm. There seemed to be a tendency for jobs manned by workers of a certain age in one firm to be manned by workers of a similar age in other firms. Some of the findings of the investigation ran counter to generally accepted views. Thus it is commonly believed that older workers tend to be engaged in non-productive processes, such as work in the tool-room and maintenance. In fact, however, men in these jobs proved to be no older and in some cases significantly younger than those on production work.

The main purpose of the investigations now in hand at Bristol is to determine what is responsible for the differences in average age on various jobs. The unit is following up about 450 men who have required changes of job, trying to discover the reasons for their wishing to change. Secondly, it is comparing the views of younger (20–30 years) and older (45–55 years) men on their work, their equipment and their firms. Thirdly, samples of work being undertaken by older and younger groups are being subjected to detailed analysis.

Griew referred to a number of points that have already emerged from these investigations. The amount of bodily activity in which younger workers engage is significantly higher than that in which older workers engage, and this applied irrespective of the 'load' of the job. The amount of attention paid visually by older workers to their work seemed to be substantially lower than that paid by younger workers. Another finding, rather hard at present to interpret, is that in the case of older machinists the ratio of the numbers of controls used to the total number present on the machine is invariably higher. He concluded by urging the importance of a sound theoretical foundation for research into the occupational aspects of ageing.

The third speaker in the symposium, C. Fleming (Sheffield), was unfortunately prevented by illness from reading his paper in Dublin. He was to have surveyed community attitudes to population ageing in Great Britain, and the gaps in the present plans for research. In Great Britain attention is still on 'old age' rather than on 'ageing'. Hospitals have developed geriatric services and there has been an increased provision of voluntary and statutory social services for the aged, but preventive geriatrics and constructive medicine are still in an early stage. Research on ageing is still fragmentary and unco-ordinated, and there has as yet been little contribution from sociology, social medicine, and economics. Education for ageing has been lacking in Great Britain in comparison with the United States. There is need for adequate organization in Great Britain for promoting research and community education on ageing. An institute of gerontology, suitably constituted and financed, would facilitate contributions from all disciplines involved. L. S. HEARNSHAW

# BIOGEOGRAPHICAL SIGNIFICANCE OF ANEITYUM ISLAND, NEW HEBRIDES

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ANEITYUM, southernmost of the New Hebrides Archipelago, is a small island, about nine and a half miles wide and seven miles long. It is accounted of no economic importance to the Condominium, but is of exceptional value to taxonomists owing to its position between the ancient land of New Caledonia to the west and other Pacific islands to the east. Thus it constitutes a link for those who study the dispersal of species in that region.

Erromango, Tanna and Aneityum, the three southern islands, presumably formed one land-mass in the past, and that this was connected with New Caledonia is evidenced by their Australasian flora and fauna. This refers particularly to Erromango and Aneityum, because Tanna has been subjected to severe volcanic disturbance, and the plants and insects are comparatively uninteresting. There is an active volcano on Tanna to-day. Aneityum is also volcanic but possesses a far richer fauna and flora, suggesting the permanence of older land. There is a Papuasian element in the southern group attributable to a connexion with the northern group during the folding movements of the Miocene–Pliocene Periods. The northern islands, on the contrary, are basically Papuasian with an Australasian element due to that same interchange of species. There exists in that archipelago, therefore, a zoo-geographical line analogous to Wallace's Line, and similarly not sharply defined. Aneityum is the crossroads of two distinct trends of migration.

It is an advantage to taxonomists to recognize this line because Pacific species can be traced back to the country of their origin, via the northern New Hebrides and the Solomon Islands to New Guinea in one direction, and via the southern New Hebrides and New Caledonia to Australia in the other.

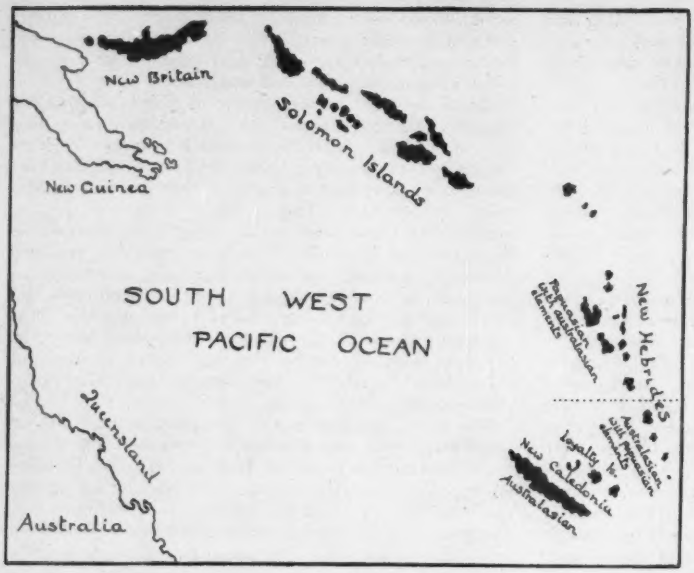


Fig. 1

Botanists have established the close affinity between the flora of the southern group and that of New Caledonia. Species which had been considered endemic to the latter are now known to occur on the former, including *Araucaria columnaris* Forster (= *cookii* Br.), nine other flowering plants and seven species of ferns. My collections made on Aneityum have added eleven species of insects derived from Australia which are either conspecific with those of New Caledonia or are island races. The list will doubtless be augmented when the distribution of other groups has been systematically studied, but already we have here a working hypothesis.

The very peculiar forms of New Caledonia, including two endemic families of plants and one endemic family of birds, the *kagy*, are neo-endemic, due to isolation of old land over a long period. These would not be expected to occur outside that island.

We thus find most interesting support biologically for palæogeologists who postulate the first fracture in this eastern section of the Australian shelf as having separated New Caledonia from Queensland during the late Cretaceous Period. Biological evidence suggests that the existing land-mass then included the southern islands of the New Hebrides, until further dislocation took place with subsidence of land throughout the late Miocene and early Pliocene Periods, which isolated New Caledonia and formed the New Hebrides Archipelago.

It must not be ignored with regard to the Papuasian forms which are present on the southern islands that these can derive from New Guinea either via the northern group or from tropical Queensland—which is also Papuasian owing to former land bridges—via New Caledonia. Expert knowledge of any particular zoological group can differentiate between species belonging to these two migrations. But if the colonization of islands could be considered due mainly to adventitious means of introduction, there would not exist such distinct faunal areas.

# INTERACTION BETWEEN ORGANIC HYDROXY ACIDS AND SILICIC AND GERMANIC ACIDS IN AQUEOUS SOLUTIONS

By E. R. CLARK and J. A. WADDAMS
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During recent years, much work has been carried out in European and American laboratories on the etiology of silicosis. One result of these studies has been the accumulation of an increasing number of observations which are opposed to the formerly widely held solubility theory of silicosis[1,2]. It is maintained by those supporting this theory that silicic acids dissolved from inhaled siliceous dusts are responsible for the initiation of fibrosis in this disease. The presumed biochemical processes underlying this action have been speculated upon in a few cases, but very little experimental work has been carried out on the postulated reactions.

Exploratory work on possible reactions of biochemical significance between silicic acid and α-amino-acids, hydroxy acids, etc., was initiated in these laboratories some time ago. Considerable experimental difficulties were encountered in this work, to which reference is made later. More recently, we have made parallel studies on germanic acid derived from the crystallographic modification of germanium dioxide isomorphous with quartz in the hope of throwing light on the less tractable systems containing silicic acids. This work has utilized solubility, conductimetric, polarimetric, *p*H and viscosity measurements to follow the interactions occurring between germanic acid in aqueous solution and a wide range of hydroxy acids. The formation of a number of definite stoichiometric complexes has been revealed in these systems. The more important of these are summarized in Table 1.

No evidence of complex formation was found using tropic acid, diglycollic acid, glyceric acid, ascorbic acid, and γ-hydroxybutyric acid.

Of the complexes recorded in Table 1, only those derived from tartaric acid have previously been reported. G. V. R. Mattock[3] studied the reactions of tartaric, malic and succinic acids with solutions of germanium dioxide and described the 1 : 1 and 1 : 2 germanotartrates for the first time.

Mlle. O. Vartapetian and M. A. Tchakirian[4] also demonstrated the formation of the 1 : 1 germano-tartrate complex by *p*H, conductivity and optical activity studies.

Diagrams illustrating the kind of results obtained in the work here reported are shown in Figs. 1–3. In each case the curves show the results obtained (*a*) in the presence of germanium dioxide and (*b*) in its absence. These curves were obtained using gluconic acid, but essentially similar plots were given by each of the substances in Table 1.

In certain cases it is possible to separate the complexes recorded in Table 1 in crystalline form. That formed between germanic acid and mandelic acid has been obtained in a pure form and has been shown to give an X-ray diffraction diagram markedly different from those yielded by the parent materials.

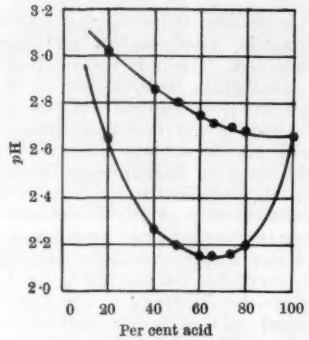


Fig. 1

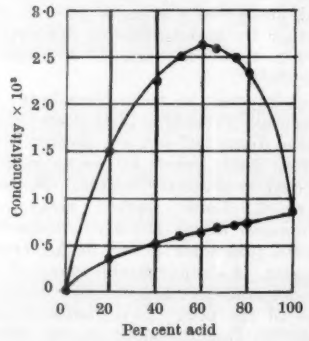


Fig. 2

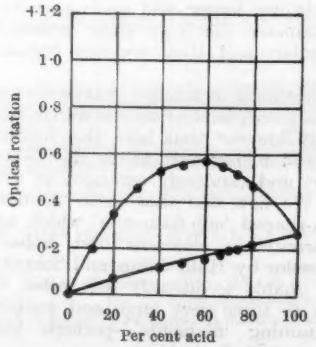


Fig. 3

Table 1

| | Parent hydroxy acid | Complex indicated by (A) Conductimetric observations (mol. Ge/mol. acid) | (B) Polarimetric observations (mol. Ge/mol. acid) | (C) *p*H measurements (mol. Ge/mol. acid) |
|---|---|---|---|---|
| 1 | Gluconic acid | 2 : 3 | 2 : 3 | 2 : 3 |
| 2 | *dl*-Malic acid | 1 : 3 | — | 1 : 3 |
| 3 | *l*-Malic acid | 1 : 3 | + | 1 : 3 |
| 4 | Dihydroxytartaric acid | 1 : 2 | — | 1 : 2 |
| 5 | Dihydroxymaleic acid | 1 : 2 | — | 1 : 2 |
| 6 | Mucic acid | 1 : 2 | — | 1 : 2 |
| 7 | Citric acid | 1 : 2 | — | 1 : 2 |
| 8 | α-Hydroxybutyric acid | 1 : 3 | — | 1 : 3 |
| 9 | Lactic acid | 1 : 3 or 1 : 4 | 1 : 3 or 1 : 4 | 1 : 3 or 1 : 4 |
| 10 | *dl*-Mandelic acid | 1 : 3 | — | 1 : 3 |
| 11 | Quinic acid | 1 : 3 | — | 1 : 3 |
| 12 | Cyclopentanol-1-carboxylic acid | 1 : 2 | — | 1 : 2 |
| 13 | D-Galactono-γ-lactone | 1 : 3 | 1 : 3 | 1 : 3 |
| 14 | L-Gulonic-γ-lactone | 1 : 4 | — | 1 : 4 |
| 15 | D(+)Arabonic-γ-lactone | 1 : 4 | 1 : 4 | 1 : 4 |
| 16 | D-Ribonolactone | 1 : 3 | 1 : 3 | 1 : 3 |
| 17 | Lactobiono-δ-lactone | 1 : 2 | — | 1 : 2 |
| 18 | Glucuronolactone | 1 : 8 | — | 1 : 8 |
| 19 | Tartaric acid‡ | 1 : 1 | 1 : 1 | 1 : 1 |

+ Qualitative evidence only. The specific rotation of *l*-malic acid is too low to give conclusive results.

Potentiometric titration of the aqueous solutions of the complexes with sodium hydroxide solution indicates that all the carboxylic acid groups of the original acid are not available for neutralization in the complex. It would therefore seem that hydroxyl and carboxylic acid groups are involved in the formation of these complexes.

Further studies on the structures of these substances and the possibility of producing insoluble salts of the complexes with bases such as procaine, quinine, etc., are in hand.

The investigation of the possible formation of related complexes involving silicon in place of germanium is rendered difficult, first because of the extremely low conductivity of solutions of pure monosilicic acid, and secondly because one must work at a concentration below that at which polymerization of this substance occurs. This limit has been shown in these laboratories[5] to be equivalent to 13–15 mgm. silica per 100 ml. An extremely sensitive a.c. bridge method using a cathode-ray oscilloscope for the determination of the balance point has been used which is capable of detecting conductivity changes smaller than those to be anticipated in complex formation. Using monosilicic acid prepared in a variety of ways, no evidence of complex formation between this substance and the hydroxy acids examined could be obtained. Negative results were also obtained in polarimetric studies.

It must therefore be concluded that silicic acid does not yield the type of complexes to which its germanium analogue gives rise even at concentrations appreciably higher than those encountered in the tissue fluids of the silicotic lung.

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# STRUCTURE OF SMOOTH MUSCLES

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DURING the past few years, it has become possible to analyse the structure of muscle fibres in sufficient detail to obtain a picture of the behaviour of their submicroscopic protein filaments during contraction. The methods which have made this feasible have been applied almost exclusively to cross-striated muscles. In order to understand the mechanism of contraction, it will be essential to analyse in similar detail the structure of fibres which lack striations and are perhaps less specialized. Material with outstanding advantages for this purpose is available in the smooth muscles of molluscs. A comparative study is being made of these and other smooth muscles, and in this account we shall summarize some recent results and describe in rather more detail a particular type of fibre where the myofibrils are helical and consist of two kinds of cross-linked filaments resembling those found in cross-striated muscles.

## Methods

It is well known that smooth muscle fibres are very thin: none that we have examined measures more than about 10$\mu$ across. Intact isolated fibres can therefore be studied with the highest resolving power of the phase-contrast microscope; the images seen are very helpful for the interpretation of electron micrographs.

The structure of fibres at various lengths has been investigated in a phase-contrast microscope with an objective of *N.A.* 1·3. The fibres were isolated by teasing from muscles which had been stabilized at defined lengths either by glycerol extraction (using a modification[1] of Szent-Györgyi's technique) or by fixation in 5 per cent formaldehyde buffered at *p*H 7·0. The structural changes during contraction were also followed in glycerol-extracted fibres (suspended in 0·1 *M* potassium chloride, $10^{-3}$ *M* magnesium chloride, *p*H 7·0) under the microscope while the preparation was irrigated with a solution of about $10^{-4}$ *M* adenosine triphosphate in the same potassium chloride solution.

Glycerol-extracted muscle offers great advantages for electron microscopy[2] because it can be separated into extremely small fibre bundles for fixation. Fresh muscles were also used. In both cases fixation was for 30 min. or 1 hr. in a 1 per cent osmium tetroxide solution containing 0·12 *M* sodium chloride and veronal–acetate buffer[3] at *p*H 7·4. The material was washed for 30 min. in 0·1 *M* potassium chloride at *p*H 7·0, and then dehydrated in a series of ethanol solutions (50, 70, 90, 95 per cent: 2 hr. in each) and stained for 12–18 hr. in 1 per cent phosphotungstic acid dissolved in ethanol. Methacrylate or 'Araldite'[4] was used for imbedding. Thin sections were cut on a microtome designed by Dr. H. E. Huxley (prototype described in ref. 5), mounted on carbon films and examined in a Siemens 'Elmiskop I'.

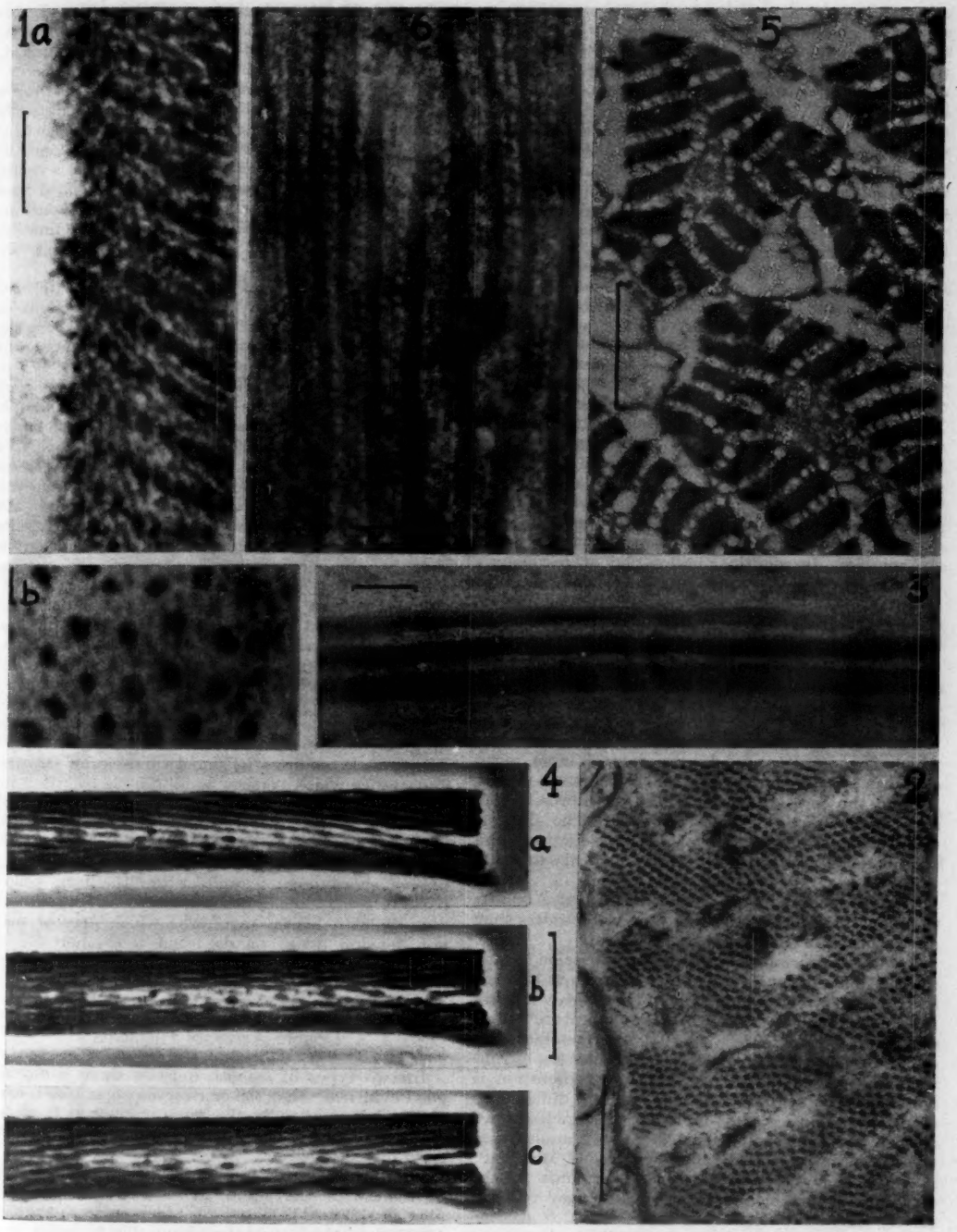
## The Diversity of Smooth Muscles

Smooth muscles from a variety of molluscs and also from annelids, *Phascolosoma* and vertebrates have been examined. The only feature they have in common to distinguish them from cross-striated muscles is that the filaments are not aligned into *A* and *I* bands. Some of the more interesting results of this survey will now be summarized. (The work on the white adductors of lamellibranch molluscs was done with Mr. G. F. Elliott.)

The myofilaments vary greatly in size and arrangement, and they may or may not be grouped together into fibrils. In the bladder muscles of the frog all the filaments are very thin—about 50 A. in diameter; no regularity can be discerned in the way in which they are packed side by side; and although the interior of the muscle fibre is not completely uniform in appearance, it is not possible to point to any differentiated groups of filaments (fibrils) separated from each other by regions free of filaments (sarcoplasm). Other vertebrate smooth muscles appear to be similar[6,14,15].

In striking contrast to these vertebrate muscles, the smooth muscle fibres of cephalopods (which have about the same diameter) contain distinct myofibrils, separated from each other by sarcoplasm with a highly organized 'reticulum'[16] system. Moreover, the fibrils consist of closely packed arrays of large filaments (diameter about 120 A.) between which lie small filaments (diameter about 50 A.) cross-linked to the large ones. A similar double array of filaments exists in cross-striated muscles[5,7] and in the smooth muscle fibres of the pharynx retractor of the snail, *Helix pomatia*[12]. But the snail muscle differs from the cephalopod muscle in several respects. The big filaments are larger and more variable in size (average diameter 250 A.); their arrangement is rather irregular, and they are not organized into fibrils.

Yet another kind of smooth muscle fibre is found in the white (slow) part of lamellibranch adductors. It is already known[8] that here the 'filaments' are very large and highly variable in size (500–1500 A. in diameter) and randomly arranged in the lateral direction. We now find that these 'filaments' contain ribbon-shaped 'sub-filaments' which appear to be the paramyosin elements first isolated from blended muscles by Hall, Jakus and Schmitt[11]. We have been unable to identify any other filaments cross-linked to these very large and complex paramyosin-containing 'filaments'—perhaps the latter function as myofibrils.




All the electron micrographs (Figs. 1, 2, 3, 5 and 6) are of material extracted with glycerol, fixed in osmium tetroxide and stained with phosphotungstic acid

Fig. 1, *a* and *b*. Transverse sections through fibrils in squid muscle. Magnification mark, 0·1$\mu$

Fig. 2. Transverse section through a fibre in the yellow part of oyster adductor muscle. Magnification mark, 1$\mu$

Fig. 3. Longitudinal section through fibril in earthworm muscle. Magnification mark, 0·1$\mu$

Fig. 4, *a*, *b* and *c*. Photographs at different focal levels through a squid fibre at rest-length fixed in formaldehyde. Magnification mark, 10$\mu$

Fig. 5. Transverse section through squid fibres. Magnification mark, 1$\mu$

Fig. 6. Longitudinal section through a squid fibril. Magnification mark, 0·1$\mu$

It is known that paramyosin structure is not confined to slow lamellibranch adductors[10–12], but it may be even more widespread than has hitherto been realized. We have found an axial period like that of paramyosin in sectioned body-wall muscles of the earthworm (Fig. 3). This is of particular interest because these muscles resemble those of cephalopods in having well-differentiated myofibrils[9] which are helically arranged. The tinted (fast) parts of some lamellibranch adductor muscles, for example in the oyster (Fig. 2), also have helical myofibrils, and here the presence of paramyosin has been shown by X-ray diffraction[12,13].

## Helical Configuration of Moyfibrils

In the funnel retractor and mantle muscles of the squid, the myofibrils are helical. This can clearly be seen in the intact isolated fibre viewed at different focal levels in the phase-contrast microscope (Fig. 4). There is a single layer of fibrils lying in the periphery of the fibre. When the whole of the helix is in focus, the fibre shows the appearance known as 'double oblique striation'; but this is a misleading term, because the muscle is smooth. The helix is left-handed, and the angle it makes to the fibre axis depends on the degree of extension or contraction of the muscle. In mantle muscles tied at rest-length and fixed in formaldehyde, the angle was found to be small (6–12°); in other fibres allowed to shorten during fixation, the angles were greater (14–18°). Change of angle during contraction has been observed under the microscope in material extracted with glycerol and treated with adenosine triphosphate; in this case the angle can increase to as much as 60°.

The fibre is 5–10$\mu$ in diameter and has a core which is mostly occupied by a row of large mitochondria; the single nucleus lies among them. Around the core are arranged the myofibrils, which are ribbon-shaped and lie radially. The fibre is usually somewhat triangular in cross-section, and neighbouring fibres are closely packed together (Fig. 5).

The filaments composing the fibril always appear to follow the same direction as the fibril; unless they are rather short, they must be helical.

The appearance of 'double oblique striation' in the muscle fibres of many different invertebrate animals has been known for a long time. It has been variously interpreted, and in the most recent literature[17,18] on molluscan muscles it is regarded as an artefact produced by distortion in cross-striated muscles. Probably one reason for this mistaken interpretation is the fact that contractile elements are difficult to study in stained sections; moreover, alcohol fixation[18] shrinks the fibres and makes them so granular that the fibrils are obscured. Ballowitz[19] and Marceau[20] had previously published detailed accounts of the structure of cephalopod muscles, and they realized clearly that the fibrils are helical.

A helical configuration of myofibrils has been observed not only in cephalopod muscles, but also in the yellow part of the oyster adductor and in the adductors of *Ensis ensis*; in all these cases the angle made between the helix and the fibre axis increases as the fibre contracts, as can be seen when material extracted with glycerol is treated with adenosine triphosphate under the microscope.

Annelids also have helical myofibrils in their body-wall muscles[9]. In *Lumbricus*, *Nepthys* and *Myxicola*, it has been found that the helix is right-handed, whereas in the squid it is left-handed.

Dr. H. E. Huxley has pointed out to us that a muscle fibre with helically arranged contractile elements could develop tension and shorten if the core around which the helix is wound remains at constant volume and if the fibre cannot twist. This is a useful working hypothesis, because it may be assumed that the volume of the fibre remains more or less constant during contraction, and histological examination indicates that the fibres in the muscle are effectively anchored by connective tissue.

In many lamellibranchs (for example, *Cardium*) the yellow part of the adductor shows no signs of helical elements when it is at physiological lengths, but looks like a classical smooth muscle with numerous 'fibrils' parallel to the long axis of the fibre. When, however, it is allowed to shorten below physiological length—by breaking the hinge ligament, for example—then some very interesting patterns of dense bands appear in the fibres. These bands are obliquely or even helically arranged. Marceau[21] may in some cases have confused such appearances with helical myofibrils. Their configuration underlines the tendency for structures in molluscan muscles to be arranged helically. A similar tendency is seen in the cross-striated part of the scallop adductor.

Thus, at least three types of smooth muscles can be distinguished in molluscs by major structural differences discernible in the light-microscope. Some of these differences are only revealed when the muscles are allowed to shorten excessively, and they can be studied not only in fixed material but also during contraction induced by adenosine triphosphate in glycerol-extracted fibres under the microscope. The three types are: (i) smooth muscles of classical appearance which persists at all muscle lengths; for example, the slow, white parts of lamellibranch adductors; (ii) smooth muscles which have the classical appearance at physiological lengths, but develop oblique or helical dense bands on excessive shortening; examples are the fast, yellow parts of some lamellibranch adductors; (iii) smooth muscles with helical myofibrils which may or may not develop dense bands when they shorten; in the squid they do not, but in the yellow part of the oyster adductor, they do.

## Double Array of Filaments

In two types of smooth muscles there is already good evidence[22] that the contractile apparatus is constructed in essentially the same manner as in cross-striated muscles[2]: it consists of two types of filaments cross-linked together.

In transverse section, a fibril in the funnel retractor or mantle of the squid shows a double array of filaments (Fig. 1). The larger filaments are angular, 100–140 A. thick, and lie about 350 A. apart in a hexagonal array. Enclosed within this array are smaller filaments, about 50 A. in diameter; their arrangement appears to be rather irregular, and there are frequently more than six around each thick filament. The bridges linking these two kinds of filaments are clearly seen in longitudinal sections (Fig. 6), where they are spaced about 150 A. apart

in the axial direction, and arranged in the same manner as in rabbit psoas muscle.

In the pharynx retractor muscles of *Helix pomatia*, both the large and the small filaments are irregularly arranged, and there are many small filaments clustered around each large one and cross-linked to it; here the large filaments are thicker (usually 250 A.) than in the squid, but the small filaments are of about the same size. The axial arrangement of the bridges is the same as in the squid.

The whole length of one of these smooth muscle fibrils is therefore constructed in much the same manner as the *A* band of a cross-striated muscle[2,7]. It is not yet known, and it may be difficult to determine, whether the individual filaments in smooth muscles are continuous or discontinuous along the length of the fibril. It seems likely, however, that they are discontinuous. There are two reasons for this opinion. First, the existence of a double array of cross-linked filaments strongly suggests that these muscles contract by a 'sliding mechanism' like cross-striated muscles[23,24]. Secondly, the low-angle X-ray diffraction patterns of clam adductor muscles do not change when the length of muscle is altered[25]; in cross-striated muscles, a similar feature[26] is explicable on the hypothesis that the filaments slide past each other without changing their lengths[23,24].

## Comparison between Smooth and Cross-striated Muscle

If the model we propose for these smooth muscles is correct, then certain features can easily be explained. The lack of cross-striation is clearly due to the absence of any transverse alignment of the filaments, as suggested earlier[24]; there are no regions consisting—like *I* bands—of thin filaments alone, and there are no regions where the thick filaments lie in transverse arrays, as in *A* bands. Moreover, the absence of *Z* and *M* lines should allow unlimited sliding of filaments relative to each other, so that such a muscle might be able to develop tension over a very wide range of lengths (as, indeed, it does in *Helix*[27] and *Holothuria*[28], for example) because cross-links could always be formed between the filaments, and, according to the theory[23] elaborated by A. F. Huxley[24] for cross-striated muscles, tension is determined by the number of cross-links.

Contraction bands in striated muscles develop when the *Z* lines meet the *A* band filaments[23]. Such bands would not be expected to occur in smooth muscles, and indeed we have not observed them within the physiological range of lengths. The nature of the dense bands described earlier in this article in certain excessively shortened molluscan muscles is now being investigated.

The fundamental similarity between cross-striated and smooth muscles is already becoming apparent from recent physiological investigations. Thus contraction is accompanied by similar optical[31] and thermal[32] changes; and force–velocity and length–tension relations are similar[27,30,34], as are the events accompanying stress relaxation[32]. Such differences as have been found are quantitative; smooth muscles are generally slower[32] and can maintain tension more economically[33]. Thus when measurements are made of the time to reach peak isometric twitch tension and of the half-decay time of this tension, it is found that in the smooth muscles from *Helix*, *Pinna*, *Mytilus* and *Pecten*, the ratio of these times of rise and fall ranges from 1 : 8 to 1 : 20, whereas in cross-striated muscles (and in squid mantle muscle) the ratio is no greater than 1 : 2 (Abbott, B. C., and Lowy, J., unpublished work). This finding cannot yet be explained in terms of structure; perhaps chemical factors are of even greater importance.

The significance of cross-striation remained unexplained. There is likely to be more than one reason for it. As regards the usual suggestion that cross-striation represents specialization for speed, it is well to remember that the gut muscles of arthropods are cross-striated. Similarly, the gut muscles in squid have the same helical arrangement of smooth myofibrils as is present in the mantle and retractor muscles, which are the fastest smooth muscles that have so far been studied.

We are much indebted to Dr. H. E. Huxley for help with electron microscope techniques, and for discussing this investigation with us at all stages. We are also grateful to Mr. H. R. Munden for technical assistance. We thank Prof. J. T. Randall and Dr. H. B. Fell for their encouragement of this work, and the director and staff of the Plymouth laboratory of the Marine Biological Association for supplying many of the animals and for laboratory facilities. One of us (J. L.) acknowledges the financial support of the Nuffield Foundation.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Electron Microscope Studies on Colloidal Silver Iodide employing Cinematographic Techniques

THE examination of crystals of silver halides in the electron microscope is of considerable interest in view of their importance in photography. So far, most research has been carried out with crystals from photographic emulsions having sizes of the order of 5$\mu$ or greater. However, crystals of such magnitude suffer from the disadvantage that they are sufficiently thick to be opaque to an electron beam and usually decompose rapidly in the beam[1]; this is particularly so with silver bromide, which has been most investigated. This has led largely to the use of replica techniques for their examination[2]. Particles of colloidal dimensions seem to have received very little attention, possibly owing to the relatively low magnification and resolving powers of earlier electron microscopes.

Recently, in these laboratories, we have carried out extensive research on the formation and growth of colloidal particles using the Siemens Elmiskop I[3], which allows direct examination of specimens at instrumental magnifications of up to × 80,000 and × 160,000. The instrument was also modified for microdiffraction observations according to the method of Riecke[4]. Sols of silver iodide (negatively charged, stabilized by excess of iodide ions) may be produced having particles of various sizes[5] (10–5000 A.) and well-defined shapes and thicknesses according to the conditions of preparation; the thinner specimens to some extent transmit electrons. The predominant two-dimensional shapes are hexagonal and triangular; examination by microdiffraction shows them to be single crystals having a hexagonal structure.

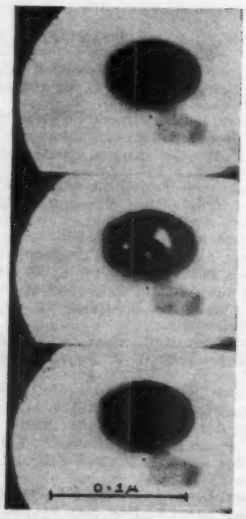


Fig. 1. A sequence from a ciné film taken directly from the electron microscope screen showing a single crystal of silver iodide undergoing considerable contrast changes (× 200,000)

Fig. 2. Filament growth from a single tetrahedral particle of silver iodide after irradiation in the electron beam. (×100,000)

During our investigations, we discovered that silver iodide during electron irradiation shows several interesting features which appear to differ from those usually described in the literature for silver bromide; moreover, these features can be controlled. Two main types of behaviour are observed, namely, considerable changes of contrast which are mobile within the particle, and in some cases, notably with high beam intensities and certain crystal shapes, rapid filament-growth from the corners. Cinematographic recordings have been made of both these phenomena, and also of the microdiffraction patterns during these changes, by photographing directly the fluorescent screen of the electron microscope.

The nature of the contrast changes and the speed with which they occur is illustrated in Fig. 1, which shows a small single crystal of silver iodide (about 800 A. in diameter) that has undergone a considerable change in two consecutive frames of the ciné film (1/16 sec.). Regions formed during irradiation which are transparent to electrons move with great rapidity inside the crystal without effecting any change in external shape. By changing the illuminating intensity, the rate of movement can be controlled; by reducing it sufficiently, the effect can be stopped. The motion of the transparent areas continues indefinitely, without evidence of decomposition or the formation of small sputtered droplets around the particles (compare the behaviour of silver bromide[6]).

With certain types of particles a filament appears to be pushed outwards from the interior as the intensity of the electron beam is increased. It seems to form with the greatest frequency from the points of tetrahedral particles. Fig. 2 shows a filament formed from a tetrahedral particle. Closely spaced 'contrast bands' shown across the filament axis are

frequently observed, and are often seen to move with great rapidity throughout the length of the extended region. Many of the filaments appear to be flat ribbons measuring as little as 30 A. across, yet remaining quite rigid. Preliminary micro-diffraction patterns of selected areas taken on single filaments indicate that they are silver iodide and not free silver.

The nature of the mechanism by which these effects occur has not yet been fully elucidated, and a full account of both the microscopy and diffraction of this system will be published elsewhere in due course. Such effects are, no doubt, closely associated with the mobility of the lattice units in silver iodide crystals and the charging effects and increase of temperature which occur in the electron beam. In the case of hexagonal silver iodide, a transition occurs at 145·8° to a cubic form[7]. However, so far no deviation in the micro-diffraction pattern from the hexagonal form has been observed; but an extension of the work to direct observations on specimens maintained at high temperatures in the electron microscope is in progress.

Finally, an important electron optical factor in these experiments is the use of a double-condenser lens illuminating system in the Siemens Elmiskop[3]. Illuminating probes of 5μ diameter were frequently used in the present work, and under these conditions the overall rise in temperature of the specimen is considerably reduced. It is difficult, therefore, to compare irradiation effects occurring during examination in the Siemens Elmiskop with work carried out on earlier electron microscopes fitted with a single condenser lens.

We wish to thank the Agricultural Research Council for financial aid to one of us (R. W. H.), Messrs. Ilford Ltd. for generous assistance with ciné film, and Mr. R. B. Collins, Dr. V. E. Cosslett and Dr. P. B. Hirsch, for valuable discussions.

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## Nature of the Lunar Surface

Recently, Gold[1] has discussed the origin of the lunar craters and maria. He concurs in the meteorite impact theory of the origin of the craters advocated by Baldwin[2], and agrees in major conclusions on the impact of explosions with Gilvarry and Hill[3]. For strong reasons[4], Gold argues against lava as the agent producing the smooth dark surfaces of the maria (which he presumes to arise in the first instance merely as meteoritic craters considerably larger than the average). He proposes to explain the smooth surfaces by an erosion process creating dust in the highlands, coupled with a transport mechanism depositing it in the maria. The purpose of this communication is to point out the possibility of explaining simultaneously the erosion and transport required in Gold's theory, by a process known to be operative on the Earth on a large scale (in contrast to some suggestions by Gold and by Urey[4]).

It is a corollary to Gold's considerations that the Moon was formed cold; its strongly triaxial shape reflects the strength of the component materials, and it was never in hydrostatic equilibrium[1]. It follows that isostatic compensation is not, and never was, present. Terrestrially, a high level of earthquake activity of tectonic type is found where the isostatic gravity anomalies are large[5]. In spite of the approximate isostatic balance of the Earth, the total number of earthquakes is of possible order $10^6$ annually; the corresponding release of energy[6] is about $1{\cdot}2 \times 10^{27}$ ergs. These considerations are consistent with a significant level of seismic activity of tectonic type on the Moon, sustained to the present throughout its history. It may be noted[5] that maximum gravity anomalies observed in the seismically active circum-Pacific belt are somewhat in excess of − 200 milligals. Assuming the maximum width and depth[2], a surface gravity anomaly can be computed of about − 450 milligals over the centre of the Alpine valley of the Moon, for no isostatic compensation[7]. Of the two figures, that for the Moon is greater in an absolute and relative sense, since the lunar gravitational acceleration is only one-sixth that of the Earth.

It will be postulated that seismic action represents a major erosive agent on the Moon, capable of reducing surface rock to rubble and (possibly with the co-operation of other agents) to fine particles and dust, in a time short compared to the lunar age. The seismic action will fill the bottoms of the craters with detritus eroded from the inner walls, as demanded in Gold's theory. To check sufficiency of such an erosive mechanism, it may be noted that the earthquake of 1897 in Assam caused complete destruction of buildings over an area[8] of 20,000 km.$^2$. For the same degree of destruction over the entire surface of the Moon, only 2,000 comparable shocks would be needed. Since the Moon's age is of order $10^9$ years, these figures correspond to roughly one such extreme shock every million years (instead of the frequency observed on the Earth of possibly one every few centuries).

An effective transport process follows from the fact that the maria are on the average 2 km. lower than the lunar highlands[2]. The corresponding slope toward the maria is sustained only on the average, since it shows local elevations and depressions as does a mountain watershed. Intermittent moonquake activity permits the dust to escape over the rims of dust-filled depressions and to seek out the lowest gaps in obstructions, in order to slide and roll under gravity in the direction of the local slope. The seismic shaking prevents surface friction from arresting the flow, and no atmospheric resistance exists. The continual action of this process over the course of time will deposit dust from the lunar highlands in the lower maria, where its surface is maintained level by seismic agitation.

This hypothesis of seismic waves as the source of the agitation of the 'dust atmosphere' permits a considerably higher 'scale height' than does the thermal agitation suggested by Morrison[9]. Dust particles which have obtained a velocity from seismic

acceleration can gain a vertical component of velocity by rebound from surface rock, to reach heights six times that possible on the Earth. A lunar seismic wave exhibiting the maximum amplitudes of ground acceleration (500 cm./sec.²) and horizontal displacement (60 cm.) observed for an earthquake[10] could impart a horizontal velocity of approximately 200 cm./sec. to superficial dust. For perfectly elastic impact against massive rock, the maximum height of trajectory of a dust particle would be about 100 cm. These figures may correspond to an extreme assumption, but they imply that the levitation induced seismically may be sufficient for the dust to surmount minor asperities obstructing the flow. The transport mechanism suggested does not seem inadequate for the requirements of Gold's theory, in view of the low flow-rate necessary (to deposit dust to a depth of 1 mm. in $10^4$ years)[1] and the large area which can be subjected to acceleration by an earthquake (about 5,000 km.²[3] for an acceleration greater than one-fifth that of terrestrial gravity, in the case of the earthquake of 1891 in Mino and Owari, Japan)[11].

I acknowledge valuable discussions with Prof. A. J. F. Siegert, of Northwestern University, and with Dr. R. B. Baldwin.

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## Internal Flaws in Bonded Cylinders of Soft Vulcanized Rubber subjected to Tensile Loads

It is not uncommon to subject rubber-to-metal bonded components to tensile loads lower than that required to break a well-bonded unit as a routine check of the bonding efficacy[1]. We have observed that internal fractures occur in soft vulcanized natural rubber cylinders bonded to metal end-pieces when subjected to comparatively low tensile loads. Such internal flaws may well pass undetected, but their presence might be expected to impair the strength, service behaviour and life. No previous account of their occurrence is known to us.

The rubber mixes used contained little or no carbon black, and gave vulcanizates having hardnesses in the range 30–45° British Standard. The test-pieces, in the form of cylinders 2 cm. in diameter and 0·07–0·50 cm. in height, were prepared by a moulding process and bonded by means of cements ('Ty Ply' *UP* and *RC*) to metal end-pieces during vulcanization. Load-deflexion relations in tension were determined using a Hounsfield tensometer, the deflexion being imposed at a speed of 0·16 cm./min.

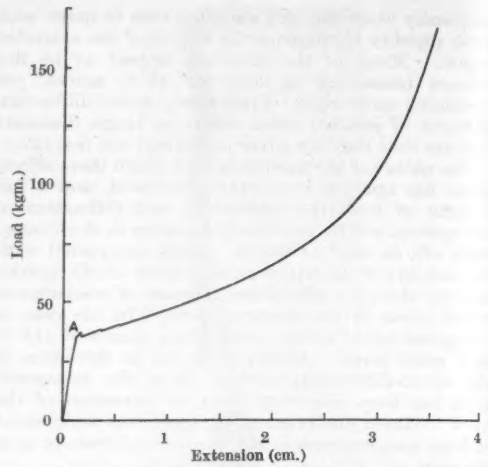


Fig. 1. Load-extension relation for a test-piece 2 cm. in diameter and 0·25 cm. thick, of hardness 45° British Standard

A typical load-deflexion relation is shown in Fig. 1. Similar relations were obtained for all the test pieces examined. Audible cracking was frequently evident from the point *A* onwards, and a cross-section of a test-piece cut open after a load of 57 kgm. had been applied is shown in Fig. 2. Several cracks about 0·3 cm. in length are visible in the central region. In thinner test-pieces a greater number of smaller cracks was found. The cracks often extended towards the bonded surfaces but did not appear to communicate with them, a thin film of rubber adjacent to the bond being unbroken.

It seems probable that the cracks are formed under the action of a negative 'hydrostatic' pressure, arising from the imposition of the present deformation on a substantially undilatable material, and analogous to the component of pressure proposed[2] to account for the load-deflexion behaviour of bonded units in compression. The magnitude of the negative pressure may be calculated in a similar manner; at the centre of a sufficiently thin test-piece it is found to be $2\sigma$, where $\sigma$ is the average tensile traction imposed on the bonded faces. From the load-deflexion relation shown in Fig. 1, therefore, cracking seems to have occurred when a negative pressure of 23 kgm./cm.² was imposed. This value may be compared with the thresholds for cavitation reported[3] for water and for glycerine of 16 and 63 kgm./cm.² respectively.

Fig. 2. Central cross-section of a test-piece 2 cm. in diameter and 0·25 cm. thick, of hardness 45° British Standard, cut open when the tensile load attained a value of 57 kgm.

It has been stated[4] that the presence of grit may lead to (unspecified) failures in the rubber when tests of rubber-to-metal bonded units are being carried out. It seems unlikely that grit was entirely responsible for the cracking reported above, since it was found in vulcanizates made from different batches of natural rubber, including one specially clean experimental sample.

This work forms part of a programme of research undertaken by the Board of the British Rubber Producers' Research Association, and will be reported in full elsewhere.

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## Preferential Ionization of Argon in the Presence of Air and its Application to Electric Discharge Devices

In this Laboratory we have used the emission from electric discharges in gases, both for promoting fast reactions in photosensitive materials (for example, crystals of metallic azides), and for illuminating such events when recorded by the techniques of high-speed photography. For both requirements it is desirable not only that the discharge be of consistent and reproducibly high luminance and illuminating power, but also that it shall be reproducible in both space and time and in electrical properties. To these ends investigations are being undertaken here to determine the effects, *inter alia*, of variations of the principal parameters of the discharge gap, for example, length and diameter of discharge, type of gas, presence and type of discharge tube or surface, method of initiation, etc. Two types of discharge, (*a*) that of a duration of several milliseconds at approximately constant intensity, and (*b*) that of a duration of a microsecond or less possessing short rise and decay periods, are of particular interest.

It has already been shown[1,2] that the millisecond discharges of constant intensity may be started along any desired path by means of a vaporizing wire, and will continue for the duration of the applied energy pulse. It was therefore possible to match the potential drop (about 30 V./cm. in air or 15 V./cm. in argon) across a suitable discharge gap to the output voltage of the energy pulse from an electrical storage network. In a particular arrangement using a Guillemin network charged to 2,800 V., gaps of 14 in. in air and 19 in. in argon were crossed at pulse energies between 0·5 and 1·0 MW. Efficient energy conversion of about 25 lumens/W. was obtained. The system affords a convenient alternative to the silica envelope discharge tube where large dissipations of energy are involved, and would prove simple to extend to much higher powers, such as 5 MW., and longer durations, such as 100–1,000 msec.

An alternative method[3] has now been established for confining microsecond discharges to a desired, and repeatable, path. It was discovered that, in the presence of a stream of gas such as argon, flowing between the electrodes of a discharge gap, the discharge confined itself to a path within the argon. Spectrograms showed that the argon stream could be reduced to a cross-section having only 0·5 mm. diameter before there occurred any excitation of the surrounding gases (in this case air), when using a discharge energy of 2·5 J. It is convenient to construct the discharge gap (Fig. 1) with one electrode drilled axially, so that the argon may be introduced continuously and cross the gap axially. Provided that the axial hole and the electrode shapes are reasonably streamlined, a non-turbulent flow is readily established, while the low velocity of flow necessary involves a negligible consumption of argon. The ratio length/diameter of the gas stream, Fig. 2, may be as large as 60 : 1, though it is easier to achieve stable flow at lower ratios. In a particular case using a ratio of 18 : 1, a discharge was established across a gap of 9 mm. length. During the discharge, the luminous zone expanded to a diameter of approximately 2 mm., a volume change of 16 : 1. The wave-forms of the light emitted showed that emission rose to its peak value of $6 \times 10^6$ candles in 0·25 μsec.,

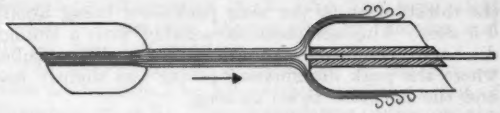

Fig. 1. An electric discharge gap blown with an axial, non-turbulent stream of argon injected through one electrode. The other electrode has been used to accommodate a trigger electrode

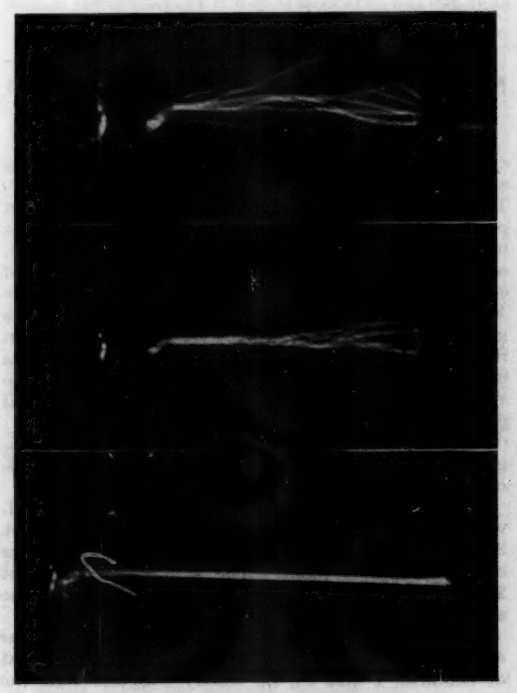

Fig. 2. Low-energy sparks between steel electrodes (*a*) in air, (*b*) in a turbulent stream of argon, and (*c*) in a non-turbulent stream of argon. Negligible expansion of the argon stream occurs and the sparks in (*c*) have superimposed randomly to fill the projected area of the stream. The ratio of length to diameter of the stream is 60 : 1

the duration at 50 per cent peak-level being about 0·5 μsec. This compares favourably with a similar discharge confined within a silica capillary tube, where the peak illuminating power was slightly less and the duration twice as long.

A considerable fraction of the emission appeared in the form of the argon 'blue' spectrum; so that, considered as a source, the electric discharge confined within an argon jet may have advantages beyond those associated with its stability of shape, size, position and emission. For example, in conjunction with a filter isolating the $\lambda = 4345$ A. region, it should prove an excellent source for high-speed interferometry.

No attempt has yet been made to establish the mechanism involved in the preferential ionization of argon in the presence of air. However, since the dielectric strengths of air alone and argon alone differ by a factor of about 2, the effect is perhaps not surprising.

Acknowledgment is made to Dr. J. S. Courtney-Pratt for his encouragement of the work and to Dr. F. P. Bowden for permission to publish this communication.

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## New Crystallite Orientations of Cellulose I in *Spirogyra* Cell-walls

During our work on barium sulphate in *Spirogyra*[1], clean cell-wall material was prepared, using methods applied earlier in isolations of cell-walls of fungi[2]. This induced us to pay some attention to certain problems concerning *Spirogyra* cell-walls. In the native state, these do not stain with chlor-zinc iodide, although Frey[3] definitely claims the presence of cellulose. Nicolai and Preston, discussing their X-ray examination of a great number of filamentous green algae[4], conclude that in very few families can it be claimed with certainty that the wall contains any cellulose common to higher plants, and that it is striking that such a well-known and often investigated genus as *Spirogyra* is still in doubt.

The main results of our X-ray and paper-chromatography investigations concerning these cell-walls may be briefly summarized as follows.

It was found that about 50 per cent of the cell-walls dissolves on successive treatments with hot 3 per cent potassium hydroxide and boiling 2 per cent hydrochloric acid. The acid dissolves about 23 per cent of the wall, and then contains galactose and xylose.

The residue yields an X-ray diagram which, so far as the spacings are concerned, corresponds to that of cellulose I and by its clarity suggests that the residue is comparatively pure cellulose.

In order to examine a possible orientation of the cellulose, cell-walls extracted as mentioned above were dried to flatness and heaped so as to form packets of nearly parallel walls. These were irradiated in directions parallel and perpendicular to the plane of the flattened cell-walls.

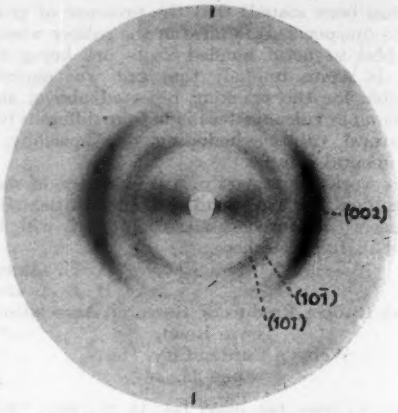


Fig. 1. X-ray diagram of packet of parallel *Spirogyra* cell-walls. X-ray beam in the plane of the walls; walls vertical and parallel to long edge of page. Note the diagonal position of the maxima of the (10$\bar{1}$) and (101) interferences

It could be concluded from the X-ray diagrams of these specimens and, as appeared later, also from similar specimens of native cell-walls, that the cellulose crystallites show a preferential orientation with a given crystal plane parallel to the wall. This has also been observed for other algae[5]. However, it is remarkable in my specimens that the oriented plane is not the one which is usually oriented parallel to the wall. So far, in both natural cellulose I membranes and membranes formed by drying down suspensions of particles of degraded cellulose I [6], (101) exclusively has been observed oriented parallel to the membrane. In my *Spirogyra* cellulose, I found the plane of orientation to be mainly (002), and also, in one species, it was observed that (10$\bar{1}$) is parallel to the wall. These orientations are shown in Figs. 1 and 2 respectively.

It has been reported that the crystallites of natural celluloses, or at least particles which probably represent the crystallites, are slightly flattened[6,7], (101) being the face of greatest extension. In my

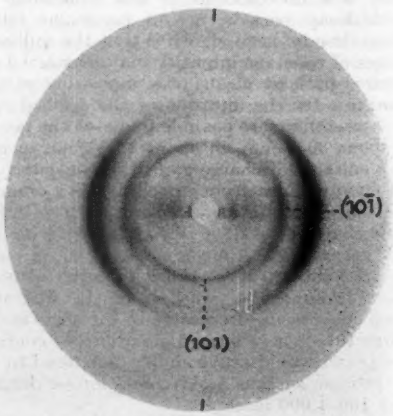


Fig. 2. Same as Fig. 1; but other species of *Spirogyra*. Note that the (10$\bar{1}$) interference arc has an equatorial position, whereas that of (101) is meridional

diagrams there is evidence suggesting that likewise in *Spirogyra* cellulose the crystallites are slightly flattened, with the face of greatest extension oriented in the plane of the cell-wall. This was supported by the low-angle scattering (not shown in Figs. 1 and 2). In other words, crystallites of natural cellulose I may also have, in addition to (101), either (002) or (10$\bar{1}$) as their face of greatest extension.

Frey-Wyssling[8] has directed attention to the fact that the OH groups on carbon atoms VI, VI′, XII and XII′ in the Meyer–Misch cellulose structure may freely rotate about the C—C bonds of these carbon atoms. He has pointed out that a given position of these OH groups, deviating from the position shown in the classical Meyer–Misch structure, could favour crystallite growth in (101). This could explain why thus far in natural celluloses (101) exclusively had been observed as the plane of lamination and growth in area of the crystallites, whereas on the basis of the Meyer–Misch model one would expect this plane to be (002).

In the light of Frey-Wyssling's considerations, our findings suggest that there might occur in Nature three structural modifications of cellulose I which differ by the position of the OH groups in question. These different OH positions might favour different directions of micelle growth.

Details of this work will be published elsewhere. It has been supported by the Netherlands Organization for Pure Research (Z.W.O.).

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## Degradation of Biologically Synthesized Lactose labelled with Carbon-14

An investigation on the labelling of lactose-$^{14}$C from milk obtained from cows and goats was recently reported by Schambye[1]. The present communication describes a similar investigation on the distribution of carbon-14 in both hexose moieties of lactose obtained from the milk of a goat employing sodium formate-$^{14}$C as the lactose precursor (lactose-$^{14}$C was obtained through the courtesy of Mr. S. Misler, of these Laboratories).

A total of 123 mgm. of lactose-$^{14}$C were hydrolysed with 10 ml. of 0·5 *N* sulphuric acid in a sealed tube for 4 hr. at 100° C.[2]. The hydrolysate was adjusted to *p*H 4·5 with a saturated solution of barium hydroxide, filtered, the precipitate washed, and the filtrate plus washings concentrated to approximately 2 ml. using a current of warm air. The condensate was then chromatographed and scanned[3]. The scan showed the distribution of radioactivity between the two hexose moieties to be equal.

The galactose and glucose were separated and isolated using a coupled column of powdered cellulose (three sections, each diminishing in volume by one-half) and an eluting solvent consisting of ethyl acetate–pyridine–water (8 : 2 : 1)[4]. The total yield of the monoses was 46 per cent for glucose and 65 per cent for galactose.

The microbiological degradations of the hexoses were accomplished by a procedure similar to that of Bernstein *et al.*[5]. This degradation relies on the conversion of hexose to equimolar amounts of carbon dioxide, ethanol and acetic acid for each mole of hexose fermented as demonstrated by Gunsalus and Gibbs[6]. *Leuconostoc mesenteroides* cells required for Warburg fermentations were grown in the stock broth supplemented with separately sterilized 0·2 per cent glucose or galactose, depending upon the substrate to be degraded.

The fermentations employed for the initial step of the monosaccharide degradations were carried out at 30° C. under nitrogen in 125-ml. Warburg flasks containing 20 ml. of cell suspension in the main compartment with 0·03–0·05 m*M* substrate in the side-arm. At the conclusion of the fermentation, carbon dioxide was absorbed in alkali, removed, the cells inactivated by the addition of concentrated sulphuric acid and separated from the fermentation mixture by centrifugation.

Ethanol was isolated from the supernatant by distillation and then oxidized to acetic acid. Lactic acid was extracted from the distilland by ether extraction and treated with sulphuric acid and chromic oxide, yielding carbon dioxide and acetic acid. The step-wise degradation of acetic acid involved decarboxylation by the use of the Schmidt reaction as described by Phares[7] and the oxidation of the resulting amine to carbon dioxide.

Table 1. Distribution of Carbon-14 in Glucose and Galactose of Lactose in Milk

| Carbon No. | 1 × 10$^{-3}$ μc./mgm. barium carbonate | Carbon No. | 1 × 10$^{-3}$ μc./mgm. barium carbonate |
|---|---|---|---|
| | Glucose | | |
| 1 | 3·3 | 2 + 3 | 1·8 |
| 2 | 1·5 | | |
| 3 | 2·0 | 4 + 5 + 6 | 3·0 |
| 4 | 3·4 | 5 + 6 | 2·8 |
| 5 | 2·4 | | |
| 6 | 2·9 | 1–6 | 2·9 |
| | Galactose | | |
| 1 | 2·9 | 2 + 3 | 1·0 |
| 2 | 0·8 | | |
| 3 | 1·1 | 4 + 5 + 6 | 3·0 |
| 4 | 3·7 | 5 + 6 | 2·3 |
| 5 | 2·3 | | |
| 6 | 2·9 | 1–6 | 2·9 |

The degradation of both hexose moieties of the biologically synthesized lactose-$^{14}$C, summarized in Table 1, showed the degree of labelling in each of the carbons of the isolated hexose moieties to be, in decreasing radioactivity: carbon numbers 4, 1, 6, 5, 3, 2.

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## Kopsine and Strychnine: a Comparative Study of their Physiological Properties

KOPSINE, an indoline alkaloid, has been isolated from the leaves of *Kopsia albiflora*, L. and *Kopsia fructosa*, A.Dc. (Apocyanaceae)[1,2]. It is a monoacidic base, and its chemical structure has been found[3] to be as shown in Fig. 1.

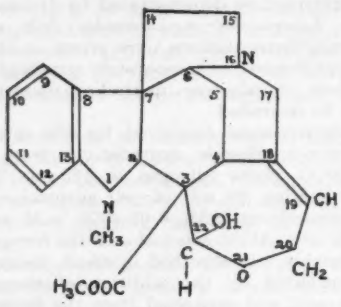


Fig. 1

Structurally, it has some similarity to some of the strychnos[4] and picralima[5,6] alkaloids. It has been suggested[3] that the structural configuration at carbon atom 3 (that is, the allocation of $-COOCH_3$ and cyclic acetal) fits into the modern conception of biogenesis of strychnos alkaloids[7].

The physiological properties of kopsine have been studied and the results have been compared to those of strychnine under identical conditions. The *p*H of the solutions of strychnine and kopsine was 6·5. A control study was made in each case by using Ringer's solution with *p*H adjusted to 6·5.

(1) Strychnine (1 mgm.) increases the excitability of the motor nerve cells. This action is very marked when strychnine is applied directly to the spinal cord. The same dose, or even higher doses, of kopsine show little effect. Preparations of spinal cord, nerve and muscles in toads were used for this work.

(2) Directly applied to the smooth muscles of the intestine or uterus of virgin rats and guinea pigs, 3 mgm. of strychnine has no effect. Kopsine in the same dose (3 mgm.) increases both the rate and amplitude of contraction of such muscles.

(3) Strychnine at a dose of 0·2–0·3 mgm. does not affect the cardiac contraction of toads. Kopsine at a dose of 0·2 mgm. reduces the cardiac contraction—both rate and amplitude. This effect becomes more pronounced as the dosage of kopsine is increased. With high dosage (0·5 mgm.), there is temporary cessation of the cardiac activity. For such investigations, toad heart perfusion experiments have been used.

(4) Neither strychnine nor kopsine influences the peripheral blood flow in toads as studied by the flow pressure perfusion technique at a dose of 100 mgm. per 100 ml. and by venous drop recording method using 5–15 mgm. of either.

(5) In urethane-anæsthetized cats, strychnine in the dose 2 mgm. per kgm. body-weight lowers the blood pressure slightly only (8–12 per cent) when the basal level of blood pressure is between 120 and 140 mm. mercury. Kopsine at a dose of 2 mgm. per kgm. body-weight reduces the blood pressure to a greater extent (15–35 per cent) under identical conditions. The hypotensive effect of kopsine (varying the dosage between 2–5 mgm. per kgm. body-weight) is much greater than that caused by strychnine of same dosage. When such a higher dosage of strychnine is used, respiration stops and there are marked convulsions and inhibition of cardiac contractions. But with higher dosage of kopsine convulsions never occurred in toads or cats.

Thus physiologically, kopsine possesses cholinergic effects, and its site of action is peripheral and not at the cerebrospinal axis as is that of strychnine. In the experimental preparations mentioned, it has also been found that kopsine and strychnine do not antagonize each other. Curiously enough, the hypotensive effect seen with kopsine has been observed in the deacetylated products of aspidospermine[8], which is of the same origin (family: Apocyanaceae) as is kopsine. Strychnos alkaloids are, however, of different origin (family: Loganiaceae).

Whether in the biogenesis of strychnos alkaloids the cholinergic action has been shifted from a peripheral effect (heart, smooth muscles, etc.) to a central effect (central nervous system) is now being investigated, as well as physiological properties of acetylated and deacetylated products of strychnine and allied substances.

We thank Dr. A. Chatterji and A. Bhattacherjya, Department of Pure Chemistry, University College of Science, University of Calcutta, for the supply of the chromatographically analysed drugs used for these experiments.

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## An Antibiotic from Maggots

IN 1929, Baer[1] introduced maggot therapy into clinical practice as an adjunct to surgery for the treatment of osteomyelitis. This technique became widely used in North America, and was extended to the treatment of other lesions where there was pyogenic infection or tissue necrosis[2]. Maggots were believed to have a threefold action within a wound: débridement of necrotic tissue by means of proteolytic enzymes[1], stimulation of granulation tissue due to the larval excretion allantoin[3] and reduction of wound infection. Baer[1] did not consider reduction of wound infection to be merely the result of débridement and tissue stimulation, and Robinson[3] has shown that allantoin, even in concentrations up to 8 per cent, has no antibacterial activity.

The work described in the present communication has been undertaken because it was considered that an anti-bacterial agent, having the properties of a true

antibiotic, might be responsible for some of the beneficial effects of maggot therapy.

Young larvæ of the black blow-fly *Phormia terraenovae* were fed on raw beef, transferred to a suitable container and sprayed with distilled water at 10-min. intervals over a period of 3 hr. The washings were allowed to drain off, carrying with them a suspension of the maggot excretions. This aqueous suspension was sterilized by heating for 30 min. under 15 lb. pressure. When diluted with suitable fluid culture media, this material was found to be bactericidal against hæmolytic streptococcus group *A* at a concentration of 150 μgm./ml. (initial inoculum $10^4$ log phase organisms/ml.). Against pneumococcus type I the potency was even more marked, a concentration of 30 μgm./ml. being bactericidal and half this amount was bacteriostatic. *Streptococcus haemolyticus* group *B* and *Streptococcus viridans* were shown to be sensitive at high dilutions. *Staphylococcus aureus* and *Clostridium welchii* were much less sensitive; *Bacillus coli*, *Proteus vulgaris*, *S. typhimurium*, *B. subtilis* and *Candida albicans* were all highly resistant. Bactericidal activity is optimum when the initial *p*H of the culture medium is between 7 and 8. In addition to this, the preparation is partially inactivated by washed agar, filtered serum and whole blood.

It has been found possible to isolate the antibiotic fraction in the washings by means of a chromatogram. 0·5 ml. of the maggot washings was deposited as a thin streak 15 cm. long on Whatman No. 1 chromatography paper. The solvent consisted of a 2 per cent solution of *p*-toluene sulphonic acid in *n*-butanol previously saturated with 2 per cent saline[4]. After drying in warm air, the chromatogram was cut into strips 2 cm. wide and 8 cm. long. These were then sterilized by ultra-violet light and embedded in agar. Antibiotic activity was detected by streaking lengthwise over the strips with *Staphylococcus aureus* (Oxford) and, following incubation, noting any areas of inhibition. Using this system, a zone of activity was located with an $R_F$ value of 0·63 (Fig. 1). By means of a cellulose column and a modification of the chromatogram technique, it has been possible to obtain relatively pure samples of the antibiotic fraction in maggot washings. It has also been found that a series of injections of 25–50 mgm. of this preparation will protect mice from the lethal effects of intraperitoneal inoculation with Type 1 pneumococci (Fig. 2). By further purification it is hoped to improve the potency of the extract and to determine the basic chemistry of the active agent. At present the exact source of the antibiotic is not known, but it seems probable that it is a product of the larvæ themselves and not of micro-organisms associated with them.

Fig. 1. Strip of chromatogram (dark rectangle) embedded in agar. The central band with a wavy margin is made up of colonies of *Staphylococcus aureus*. Note abrupt zone of inhibition at the upper end

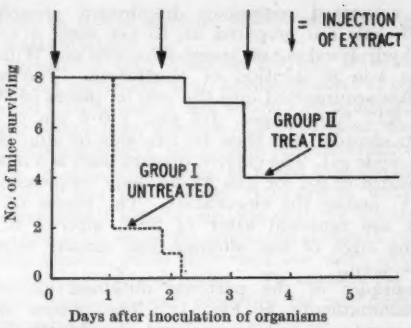


Fig. 2. Histogram showing survival times for two groups of *BALB/C* mice inoculated with $10^3$ pneumococci intraperitoneally. Group II received 25–50 mgm. of larval antibiotic extract intraperitoneally at times indicated (survivors killed after 14 days)

It is hoped to publish full details of this work elsewhere.

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## Serum Protein Differences in Cattle by Starch Gel Electrophoresis

Genetical differences obtained with cattle serum proteins by starch gel electrophoresis have been reported briefly[1]. This communication gives details of the distribution of the phenotypes, and some mating results.

The apparatus employed is similar to that of Smithies[2], except that platinum electrodes are used and all four vessels are filled with electrolyte (42 gm./l. disodium hydrogen phosphate adjusted to *p*H 7·8

with saturated potassium dihydrogen phosphate). Starch gels are prepared at 15 per cent w/v from acid-hydrolysed potato starch (Hopkins and Williams) and a 1-in-50 dilution of electrolyte. The serum samples are inserted into the gels on pieces of Whatman *E*17 filter paper, 1·3 cm. × 0·6 cm.; three serum samples can then be run side-by-side in one 4-cm. wide gel. The current density used is 5 m.amp./cm. width of gel for gels 25 cm. long (approximately 250 V. across the electrodes). The pieces of filter paper are removed after 1½ hr.; after 4 hr. the trailing edge of the albumin has usually migrated about 4 cm.

Examples of the patterns obtained are shown diagrammatically in Fig. 1. The nature of the components in one-dimensional starch gel electrophoresis has been determined by two-dimensional

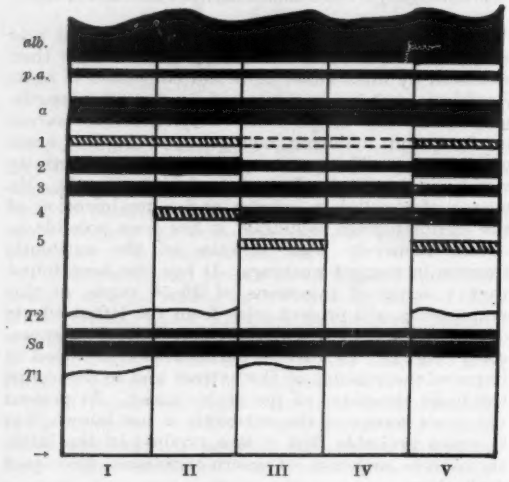


Fig. 1. Diagrammatic representation of cattle serum protein patterns by one-dimensional starch gel electrophoresis. Only the anodic side of the gel is shown. Arrow indicates position of sample insertion. I–V refer to $\beta_2$-globulin patterns, types I–V; *alb.*, part of albumin band; *p.a.*, post-albumin band (components 21 and 22, Fig. 2); 1–5, $\beta_1$-globulins; *Sα*, slow α-globulin bands (components 9 and 10, Fig. 2); *T1* and *T2*, 'thread proteins' (component 18, Fig. 2, *T2*). Solid bands, intense staining; cross-hatched, medium staining; dotted bands, faint or absent

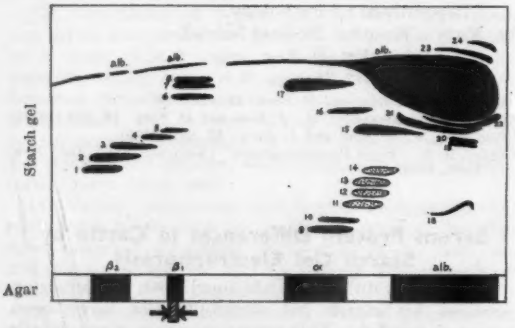


Fig. 2. Diagram prepared from epidiascope projection of starch gel after two-dimensional electrophoresis of type II serum with a *T2* 'thread protein'. The position of the zones separated in the initial agar electrophoresis is shown at the bottom of the diagram; the three γ-globulins have been cut off. Only the anodic side of the starch gel is shown. Arrows indicate position of original sample insertion in agar. *Alb.*, albumin; α, α-globulin; $\beta_1$ and $\beta_2$, β-globulin zones in agar. Components 11–14 are usually faint with poorly defined outlines

Table 1. Distribution of $\beta_2$-Globulin Phenotypes with Respect to Breed (Bulls Only)

| Breed | $\beta_2$-globulin phenotypes | | | | | Total No. of bulls |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | |
| Friesians | 33 | 48 | 4 | 32 | 3 | 120 |
| Shorthorns | 16 | 29 | 1 | 8 | 2 | 56 |
| Ayrshires | 4 | 14 | 5 | 15 | 2 | 40 |
| Herefords | 8 | 11 | 2 | 15 | nil | 36 |
| Aberdeen Angus | 4 | 3 | nil | 2 | 1 | 10 |
| Guernsey | 6 | 10 | nil | 8 | nil | 24 |
| Jersey | 10 | 4 | nil | 3 | nil | 17 |
| South Devon | 1 | 4 | nil | 9 | nil | 14 |
| Devon | 4 | 4 | nil | 9 | nil | 17 |
| Red Poll | 2 | 4 | 3 | nil | 1 | 10 |
| Lincoln Red | 1 | 3 | nil | nil | 2 | 6 |
| Welsh Black | nil | 1 | 1 | nil | nil | 2 |
| | | | | | | 352 |

Table 2. Mating Results: Mixed Breeds

| Phenotype of parents | Phenotypes of offspring | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| I × I | 6 | — | — | — | — |
| I × II | 15 | 11 | — | — | — |
| I × III | 1 | 1 | — | — | 5 |
| I × IV | 2 | 7 | | 1 | — |
| I × V | 5 | — | — | — | 2 |
| II × II | 4 | 4 | — | 5 | — |
| II × III | — | — | — | — | 2 |
| II × IV | 2 | 8 | — | 8 | — |
| II × V | 2 | 2 | 4 | — | 2 |
| III × III | — | — | 7 | 2 | — |
| III × IV | — | — | 9 | 11 | — |
| III × V | 1 | 1 | 4 | 1 | — |
| IV × IV | — | — | — | 8 | — |
| IV × V | — | 3 | 1 | — | — |
| V × V | 1 | — | — | — | 2 |

Note: The results shown were obtained from single offspring born to 150 selected cows mated to one of 33 bulls.

electrophoresis[2], first in agar and then in starch gel (Fig. 2). The $\beta_2$-globulin zone gives four, five or six components depending on the serum type, the various combinations of these components allowing recognition of five $\beta_2$-globulin phenotypes (I–V, Fig. 1). Table 1 shows the distribution of these five phenotypes among 352 bulls at the Milk Marketing Board Cattle Breeding Centres.

The $\beta_2$-globulin phenotype of an individual animal appears to remain constant, no change being observed in individual cattle on re-sampling over a period of twelve months. Prolonged storage of serum at − 15° C. has no effect on the $\beta_2$-globulin pattern obtained. Examination of forty-two pairs of monozygous twin sera showed that in each case both members of the pair gave the same $\beta_2$-globulin pattern, suggesting genetical control. Results from 150 matings are presented in Table 2.

It seems possible from the results available at present that this system is controlled by five pairs of linked genes, so that each of the individual $\beta_2$-globulins is seen in the presence of a single or double dose of one allele of the appropriate pair, but is absent in the presence of a double dose of the other allele.

The 'thread proteins' also seem to be under genetical control, resulting in four phenotypes (Fig. 1) independent of the $\beta_2$-globulin phenotypes. However, the results obtained with this system are not reproducible, and further work is required to elucidate the mechanism.

I thank Mr. G. F. Smith, chief veterinary officer of the Milk Marketing Board, for making available bull blood; also Drs. Hall and Jamieson, of the Animal Breeding Research Organization, Edinburgh,

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## Purification of β-Glucuronidase from Female Rat Preputial Gland

Because of the enormously high activity of β-glucuronidase in the preputial gland of the female rat[1], this tissue appeared to be a promising source of the purified enzyme. For other tissues employed for this purpose, the specific activity, the degree of purification and the recovery are as follows: ox liver[2] (32,000, 800-fold, 5 per cent), calf spleen[3] (7,900, 1,400-fold, 1 per cent), calf liver[4] (60,000, 9,000-fold, 10 per cent). The specific activity is expressed as μgm. phenolphthalein liberated from phenolphthalein glucuronide by 1 mgm. of protein in 1 hr. at 37° C., and the last two preparations were assayed in presence of deoxyribonucleic acid. A specific activity of 107,000 was observed with the best individual preparation from calf liver[4], and this was claimed to represent a purity of 85 per cent.

Crude preparations of the preputial gland of the female rat have specific β-glucuronidase activities similar to that quoted for the purified enzyme of calf spleen, and much higher specific activities than any yet reported can easily be obtained after four consecutive stages of fractional precipitation. In the experiment summarized in Table 1, twenty-one rats, 4–6 months old, yielded 2·2 gm. preputial gland which was homogenized in water. The homogenate was made 0·1 *M* with respect to acetate buffer, *p*H 5·2, in a final volume of 22 ml. After 2 hr. at 37° C., insoluble material was removed by centrifuging, and the supernatant was fractionated as shown. Precipitation, followed by sedimentation (10 min. at 20,000*g*) after 30 min., and dialysis of the fractions were done at 0° C., but other manipulations were at ordinary room temperature. Solutions were buffered to *p*H 5·2 with 0·1 *M* or 0·01 *M* acetate buffer, and dialysed against the more dilute buffer. Losses in enzyme activity were in part due to the discard of less-pure fractions: there appeared, for example, to be no enzyme inactivation during the final fractionation.

Table 1. One Glucuronidase Unit (G.U.) liberates 1 μgm. Phenolphthalein from 0·00063 *M*-Phenolphthalein β-Glucuronide in 1 hr. at 37° C. and *p*H 5·2 (0·05 *M* Acetate Buffer). Percentages of Saturated Ammonium Sulphate Solution and Ethanol are by Volume. Protein was determined by the Method of Lowry *et al.*[6], employing Bovine Albumin as Standard

| Fraction | G.U./mgm. protein | Recovery, G.U./gm. moist tissue |
|---|---|---|
| Homogenate | 5,850 | 944,000 |
| Supernatant | 11,200 | 979,000 |
| 20–80 per cent sat. ammon. sulphate sol. | 17,700 | 845,000 |
| 20–45 per cent ethanol | 31,000 | 564,000 |
| 33–60 per cent sat. ammon. sulphate sol. | 71,200 | 205,000 |
| 45–50 per cent ethanol | 107,000 | 188,000 |
| | 193,000* | 338,000* |

* Enzyme assay in presence of 0·03 per cent deoxyribonucleic acid.

In agreement with Fishman and his co-workers[5], the enzyme, especially in an advanced state of purity, displayed a reduction in net activity on dilution, and this was reversed by a variety of substances, such as deoxyribonucleic acid, albumin or enzyme inactivated by heat. It should, however, be noted that the figures in Table 1 are not strictly comparable with the measurements of specific enzyme activity quoted by these authors[3,4], since we employed albumin as our reference protein while they used the more chromogenic protein, chymotrypsin[6]. To correct for this, our own results should probably be multiplied by 1·5 throughout.

Since the β-glucuronidase activity of preputial gland of the female rat is under ovarian control[1], this tissue would appear to be ideal for studying the biosynthesis of the active protein.

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## Excretion of Yttrium and Lanthanum Chelates of Cyclohexane 1,2-*Trans* Diamine Tetraacetic Acid and Diethylenetriamine Pentaacetic Acid in Man

The removal of stable or radioactive toxic elements from the human body is of considerable interest[1]. The modification of tissue distribution and excretion of metal ions by chelating agents has been studied in man and animals in several laboratories[2]. Although ethylenediamine tetraacetic acid has been the most effective chelating agent thus far studied, it has the disadvantage that relatively large doses are required in order to effect a significant removal of heavy metal ions, particularly radioactive rare earths. Therefore metal chelates having stability constants higher than the corresponding metal chelates of ethylenediamine tetraacetic acid were investigated for their effectiveness in removal of rare earth elements.

This communication reports observations on the urinary excretion of intravenously administered yttrium and lanthanum chelated with *cyclo*hexane 1,2-*trans* diamine tetraacetic acid[3] (CDTA) and with diethylenetriamine pentaacetic acid[4] (DTPA). The excretion of these metal chelates has been compared with the excretion of the yttrium and lanthanum ethylenediamine tetraacetic acid chelates.

Yttrium and lanthanum chelates of ethylenediamine tetraacetic acid, *cyclo*hexane 1,2-diamine tetraacetic acid and diethylenetriamine pentaacetic acid, using 1·2 : 1 chelate to metal molar ratios, were administered intravenously to man. Yttrium and lanthanum were administered in 1·0-mgm. and 1·5-mgm. quantities labelled with yttrium-90 and lanthanum-140 respectively; they were determined in plasma samples and in aliquots of urine and the

Table 1. Plasma Levels and Cumulative Urinary Excretion of Yttrium and Lanthanum Chelates in Patient R. F.
(1 mgm. yttrium or 1·5 mgm. lanthanum ion and 5 mgm. chelating agent were injected intravenously; yttrium-90 and lanthanum-140 were used as tracers)

| Metal chelate | 4 hr. Plasma* | 4 hr. Urine† | 8 hr. Plasma* | 8 hr. Urine† | 24 hr. Plasma* | 24 hr. Urine† |
|---|---|---|---|---|---|---|
| Y–EDTA | 5·3 | 36·5 | 0·9 | 43·7 | 0·5 | 46·7 |
| Y–CDTA | 5·7 | 68·4 | 2·3 | 87·1 | 0‡ | 97·6 |
| Y–DTPA | 5·0 | 75·0 | 1·8 | 93·0 | 0‡ | 101·3 |
| La–EDTA | 40·5 | 1·4 | 23·1 | 1·6 | 8·1 | 2·1 |
| La–CDTA | 25·5 | 8·2 | 17·7 | 8·6 | 6·0 | 12·1 |
| La–DTPA | 8·4 | 50·8 | 3·4 | 58·0 | 1·0 | 60·5 |

* Percentage of the administered dose in total plasma volume.
† Percentage of the administered dose.
‡ Background.

values expressed as percentages of the injected dose. On the basis of previous studies of yttrium and lanthanum excretion[2b], it was assumed that the metals were excreted by the kidney mainly as the metal chelate. A representative example of a comparative study carried out with the yttrium and lanthanum chelates in one patient is shown in Table 1.

Table 2 lists the twenty-four hour cumulative urinary excretion in a group of patients receiving the yttrium and lanthanum chelates. These results show quite conclusively that even at tracer-levels yttrium *cyclo*hexane 1,2-*trans* diamine tetraacetic acid and yttrium diethylenetriamine pentaacetic acid are excreted within eight hours in amounts approaching 100 per cent of the administered dose, whereas yttrium ethylenediamine tetraacetic acid is eliminated somewhat in excess of 50 per cent of the injected dose. The first is excreted in slightly smaller amounts than the second. The superiority of diethylenetriamine pentaacetic acid over *cyclo*hexane 1,2-*trans* diamine tetraacetic acid in effecting lanthanum excretion is indicated by the results in Tables 1 and 2.

The complete urinary excretion of the yttrium diethylenetriamine pentaacetic acid chelate suggests the use of the radioactive metal chelate as a vehicle for introducing ionizing radiation into the body. This type of treatment would permit a controlled exposure to total-body radiation over a period of several hours to days as compared to a relatively brief exposure to the same amount of radiation by X-rays. The quantity of radiation and the time of exposure could be controlled by the radioactivity of the isotope, the speed of infusion and the molar ratio of the metal to the chelate.

Results correlating the urinary excretion of chelated yttrium with the stability constant of the metal chelate have been reported in a previous communication from this laboratory[5]. These indicated that the higher the stability constant of the metal chelate, the larger the excretion. The stability constants of the lanthanum and yttrium *cyclo*hexane 1,2-*trans* diamine tetraacetate acid chelates have been found to be greater than the corresponding metal chelates of ethylenediamine tetraacetic acid[3]. Although no published data are available on the stability constants of the yttrium and lanthanum chelates of diethylenetriamine pentaacetic acid, unpublished results indicate that the latter binds polyvalent metal ions at least as strongly as *cyclo*hexane 1,2-*trans* diamine tetraacetic acid[6].

Table 2. Urinary Excretion of Yttrium and Lanthanum Chelates in 24 hr.
(1 mgm. yttrium or 1·5 mgm. lanthanum ion and 5 mgm. chelating agent were injected intravenously; yttrium-90 and lanthanum-140 were used as tracers)

| Metal chelate | No. of patients | Urinary excretion as percentage of administered dose: Range | Average |
|---|---|---|---|
| Y–EDTA | 11 | 38·3–87·6 | 55·9 |
| Y–CDTA | 13 | 75·3–97·6 | 87·9 |
| Y–DTPA | 6 | 81·6–102·4 | 96·7 |
| La–EDTA | 3 | 2·1–3·1 | 2·6 |
| La–CDTA | 3 | 9·4–12·2 | 11·2 |
| La–DTPA | 4 | 60·4–71·8 | 64·6 |

The effectiveness of a chelating agent as a detoxicant for heavy metals can be predicted from the urinary excretion of the intravenously injected metal chelate. Therefore, both *cyclo*hexane 1,2-*trans* diamine tetraacetic acid and diethylenetriamine pentaacetic acid, especially the latter, should be more effective than ethylenediamine tetraacetic acid in removing yttrium and lanthanum from body tissues and fluids. These results further support the conclusion that the stability constant of a heavy-metal chelate represents a reliable basis for predicting the effectiveness of a chelating agent in detoxifying a physiological system contaminated with heavy metal ions.

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## Site of Chloride Regulation in Marine Fish Larvæ

During current investigations into the laboratory conditions necessary for consistently successful marine fish-rearing, it has become increasingly evident that the osmotic hazard confronting the early larva is much greater than that facing the adult. Both larva and adult live under an osmotic strain, having internal salt concentrations roughly one-third that of the surrounding sea water.

The integument of the plaice larva is a thin syncytial membrane[1], partially separated from the muscular axial tissue by a voluminous sub-dermal space[2]. Its ability to do osmotic work can be critically

affected by external changes in the physico-chemical environment, and by the internal energy supply. Unfed larvæ quickly succumb to the osmotic strain, after complete loss of yolk. The thick, secretory, scaly skin of the adult, on the other hand, is virtually water- and salt-proof, osmotic leakage being restricted to the gill surface and oral membranes. Temporary starvation is never critical; food reserves provide energy for osmotic needs over long periods.

In both young and old, regulatory mechanisms are necessary to offset water loss and salt gain under the osmotic gradient. The adult swallows sea water to make good loss of water. The larger and less mobile ions, for example, magnesium, calcium and sulphate, are eliminated with the fæces[3]; water and the remaining electrolytes pass through the gut wall into the blood stream. Excess chloride is secreted to the outside by special cells in the gills[4]. The essential structural requirements for this mechanism of salt control are not generally present in emergent marine fish larvæ. The blood circulation is not yet complete and the gill filaments are absent. Where then, and how, do marine larvæ regulate their internal chloride concentration?

Copeland[5] used a modification of the Leschke chloride test for investigating the chloride secretory cells of the adult *Fundulus heteroclitus*. My larval technique is broadly based on that of Copeland. Living yolk-sac larvæ of plaice, cod and dab were washed in distilled water for 3 sec., then plunged into a dilute acid–silver nitrate solution in a dark room, under a safe light. After 3 hr. impregnation, the larvæ were washed thoroughly in distilled water to remove all traces of silver nitrate; immersed in dilute photographic developer solution for 1 hr.; rinsed; fixed in 'hypo' for ½ hr.; washed, dehydrated, cleared and mounted. Light precautions must be very strict until the 'hypo' stage.

A remarkable and consistent feature of treated larvæ is the fine, heavily stained, continuous network ramifying over the whole integument. This reticulum (Fig. 1) bears globular, corpusculate, nucleated bodies on its meshes, aggregations of which form characteristically heavy deposits around the yolk sac and in the fin fold. Smaller stained particles lie between the meshes, which at first sight appear to outline the boundaries of epithelial cells in the integument. The transverse section shown in Fig. 2 does not support the cellular theory. The network clearly has different properties from the rest of the unstained

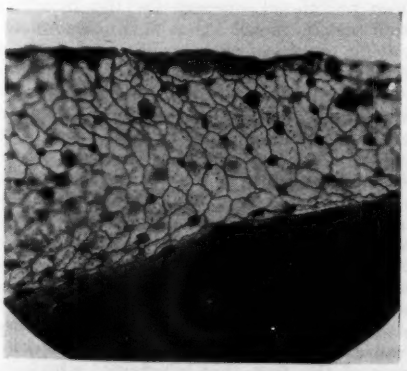

Fig. 1. Silver-stained network in dorsal marginal fin; high power. Photograph by R. Elms

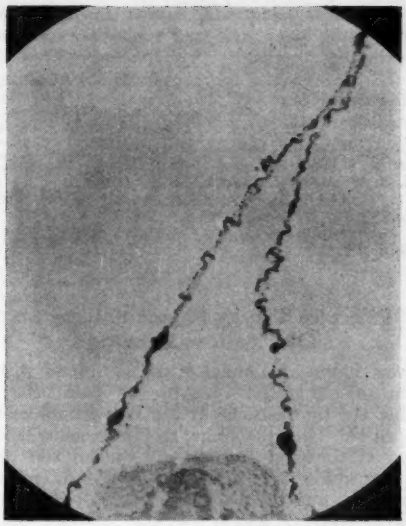

Fig. 2. Transverse section through dorsal marginal fin and larval trunk; high-power. Photograph by R. Elms

integument and lightly stained main axial tissues. If this conspicuous and regular pattern truly represents distribution of chloride in the larval plaice, then the whole thin integument, particularly around the yolk sac, is intimately concerned in regulation. The integument of a living larva, in bad conditions under the microscope, is noticeably active. The globular bodies become very prominent, and can frequently be seen to discharge their mucoid contents to the outside. Cellular discharge is always accompanied by local loss of integumental surface area, and is probably responsible for the normal diminution of the outer yolk sac during yolk utilization.

The specificity of acid–silver nitrate as a histochemical reagent has rightly been criticized by Lison[6] and many others. As well as reacting with tissue chlorides to produce silver chloride, unstable in the light, silver nitrate can be reduced directly to silver by vitamin C. Artefacts are often produced by silver salt fixatives, although rapid larval fixation in Baker's calcium-formaldehyde just before silver impregnation served to emphasize still further the regularity of the larval network. Copeland's technique assumes the initial formation of insoluble silver chloride in the tissues, made visible by controlled reduction in developer solution. I have obtained some evidence to support this assumption by using known solvents of silver chloride.

If silver-fixed larvæ are treated with 0·1 *N* solutions of ammonia, sodium thiosulphate or sodium cyanide after impregnation, negative results are always obtained on subsequent development, although the unstained globular bodies still remain visible in the integument.

Larvæ fixed in 5 per cent chloride-free formalin for 2 min., followed by normal treatment, gave positive results. Formalin-fixed larvæ allowed to remain in formalin, or distilled water, for ½ hr. gave negative results, suggesting that the cellular reactant is only loosely bound in the integumental network, and quickly diffuses out after death in chloride-free preservative.

An attempt is being made to test this histochemical evidence using one of the two available radioisotopes of chlorine.

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## Effect of Flavin Monosulphate on Old Yellow Enzyme

When flavin mononucleotide combines with the protein of old yellow enzyme to form the holoenzyme, the fluorescence of the free mononucleotide disappears[1]. This quenching of fluorescence has been attributed to bond formation between the protein and the imino NH(3) group of the flavin mononucleotide[2], and Weber[3] has suggested that the tyrosyl hydroxyl group of the protein may be responsible. In support of this hypothesis, Nygaard and Theorell[4] showed that 3,5 iodination of some of the tyrosyl groups resulted in a drastic change in the association and dissociation velocity constants. In addition to the binding of the imino NH(3) position, the extensive kinetic studies of Theorell and Nygaard[4–7] on the combination of old yellow enzyme apoprotein with its prosthetic group have indicated that the phosphoric acid residue of flavin mononucleotide is attached to (probably two) primary amino-groups in the protein.

Flavin monosulphate, the sulphate analogue of flavin mononucleotide, has been synthesized by Takahashi, Yagi and Egami[8] and shown to be a competitive inhibitor of the association reaction of the protein of D-amino-acid oxidase with its prosthetic group, flavin adenine dinucleotide[9]. The quenching of flavin derivatives by phenol has been studied by Yagi *et al.*[10,11], and it is believed that this quenching results from complex formation between the phenolic hydroxy group and the imino NH(3) group of the *iso*alloxazine nucleus. Since the fluorescence of flavin monosulphate, which is equal to that of the mononucleotide, is quenched by phenol, it was of interest to determine whether it would combine with the apoprotein of old yellow enzyme.

Old yellow enzyme was prepared according to Theorell and Åkeson[12], and the flavin mononucleotide was split from the apoprotein by the method of Warburg and Christian[13]. The recording fluorimeter of Theorell and Nygaard[6] was used in this work.

It was found that no quenching of fluorescence occurred when flavin monosulphate was added to the apoprotein of old yellow enzyme as shown in Fig. 1,*A*. That the protein was capable of combining with flavin mononucleotide with resultant quenching is shown in the same experiment (Fig. 1,*B*). In the latter case, addition of flavin mononucleotide results in an immediate increase of fluorescence followed by a gradual decrease along the kinetic curve produced as the flavin combines with the protein. The association velocity constant ($k_1$) calculated from these results is in excellent agreement with that found by Theorell and Nygaard[5] under similar conditions. The presence of flavin monosulphate in the reaction

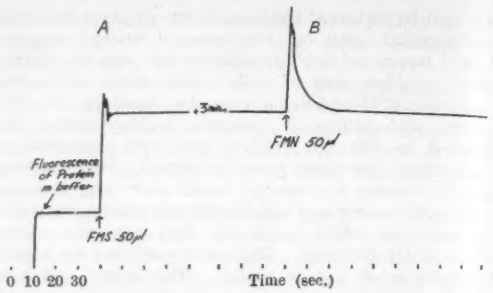


Fig. 1. Comparison of the effect on fluorescence of adding flavin monosulphate (*A*) and flavin mononucleotide (*B*) to apoprotein of old yellow enzyme. Final concentrations: apoprotein, $1{\cdot}1 \times 10^{-6}$ *M* flavin monosulphate and flavin mononucleotide, $0{\cdot}75 \times 10^{-6}$ *M*. The base-line fluorescence of the cell plus apoprotein and buffer is shown at the beginning of the record. Time is marked in 10-sec. intervals

mixture did not appear to interfere with the combination of apoprotein and flavin mononucleotide. Similar results were obtained in both phosphate and *tris* buffers at *p*H 7·0.

To determine whether the sulphate moiety of flavin monosulphate is able to combine with the sites on the protein where phosphate of flavin mononucleotide ordinarily becomes attached, kinetic studies of the combination of flavin mononucleotide and apoprotein were carried out in the presence of increasing concentrations of flavin monosulphate. No evidence of inhibition of the association reaction of flavin mononucleotide with protein was found, using the highest concentration of the monosulphate ($1 \times 10^{-6}$ *M*) permitted by the fluorimetric technique.

The capacity of flavin monosulphate to combine with old yellow enzyme was then compared with that of riboflavin, since earlier work has shown that riboflavin, at high concentrations, can be partly substituted for flavin mononucleotide[14], forming a complex with a very high dissociation constant[7]. For these experiments, the apoprotein concentration was increased to $9 \times 10^{-6}$ *M*; riboflavin and flavin monosulphate to $1 \times 10^{-6}$ *M*. No evidence of fluorescence quenching was obtained with flavin monosulphate, in contrast to the results found with riboflavin.

The finding that replacement of the phosphate by sulphate in the 5′ position of the ribose moiety renders the flavin incapable of binding to the protein provides additional support for the hypothesis of Theorell and Nygaard[5,7] that it is necessary to have both acidic groups of the phosphate of flavin mononucleotide in the anionic form in order that binding may occur. The latter investigators found that the velocity constant for the association of flavin mononucleotide and apoprotein decreases sharply as the acidity of the solution is increased, suggesting that addition of a proton to one of the acidic groups of the phosphoric acid component prevents combination. A similar explanation can be given for the failure of the sulphate residue to be attached to the protein, since it possesses only one free acidic binding site.

The observation that there is apparently no bond formation between the imino NH(3) group of flavin monosulphate and the protein is quite unexpected and more difficult to explain. This is especially so in view of the fact that riboflavin, which lacks a phosphate group, can combine with resultant quench-

ing of fluorescence, although the complex formed is highly dissociated. It must be concluded that the sulphate moiety, in some manner as yet unexplained, hinders binding between the protein and the imino NH(3) group.

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## Lack of Growth-promoting Activity of Inactivated Penicillin with Turkey Poults

THE growth response of many animals to low levels of dietary antibiotics is now well established. Extensive investigation has not demonstrated the exact mode of action of dietary antibiotic, but it is generally considered that its antibacterial activity is involved. Recently, Taylor and Gordon[1] showed that inactivated penicillin gave an increase in growth-rate of pigs as well as a reduction in the feed-conversion ratio; they suggested that the growth-promoting ability of inactivated penicillin was due to a stable end-product of the inactivated drug.

An experiment was undertaken in this laboratory to determine whether or not inactivated penicillin would stimulate growth in the domestic turkey. Broad Breasted Bronze poults one day old were placed on diets containing: no penicillin, penicillin, penicillin inactivated by autoclaving and by penicillinase. These treatments were carried out with two levels of antibiotic (7 and 14 p.p.m. procaine penicillin) in the turkey starter-ration. The experiment was carried on until the birds were four weeks old, at which time response to antibiotic in the poult has usually passed its peak. Each dietary treatment was replicated three times with sixteen poults of mixed sex per sub-group. Analysis of variance was carried out on the individual body-weights obtained at four weeks old. The results are shown in Table 1. No significant difference at the 5 per cent level of probability existed between birds fed no penicillin and those fed penicillin inactivated by heat or penicillinase. These results were uniform for both male and female poults and for the two levels. The growth response obtained with active penicillin was significant at the 1 per cent level and was of the same order of magnitude as that ordinarily obtained in this laboratory.

Table 1

| Dietary treatment | Body-weight (gm., at 4 weeks of age) | |
|---|---|---|
| | Males | Females |
| No antibiotic | 543 | 492 |
| Procaine penicillin, 7 p.p.m. | 625 | 586 |
| Procaine penicillin, 7 p.p.m. (inactivated by heat) | 553 | 518 |
| Procaine penicillin, 7 p.p.m. (inactivated by penicillinase) | 560 | 521 |
| Procaine penicillin, 14 p.p.m. | 667 | 555 |
| Procaine penicillin, 14 p.p.m. (inactivated by heat) | 563 | 521 |
| Procaine penicillin, 14 p.p.m. (inactivated by penicillinase) | 540 | 490 |
| | L.S.D. ($P < 0{\cdot}05$) 39 gm. | L.S.D. ($P < 0{\cdot}05$), 41 gm. |

In order to check the foregoing results, a second experiment was undertaken employing only one level of penicillin (7 p.p.m.). Dietary treatments were otherwise the same as in the first experiment. Each dietary treatment was replicated three times with sixteen poults per sub-group. No significant growth response was noted when inactivated penicillin was added to the ration. As in the first experiment, a significant response was obtained where active penicillin was included in the diet.

The results obtained in the two experiments indicate that, at least for the domestic turkey, penicillin inactivated by either heat or penicillinase will not cause a significant increase in growth.

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## Effect of Different Dietary Fats on the Fæcal End-Products of Cholesterol Metabolism

INVESTIGATORS in several laboratories, including our own[1], have shown that certain unsaturated fats are able to lower the serum cholesterol-level of human subjects. It is possible that this effect is achieved by an increase in the excretion of the end-products of cholesterol metabolism; hence we have commenced a study of the quantitative changes in these end-products during the administration of different dietary fats. Following the demonstration that ingested cholesterol 4-$^{14}$C is excreted mainly as cholic acid both in rats[2] and in a human bile fistula patient[3], particular attention was paid to the bile-acid content of the fæces (estimated by the method of Lewis[4]). In addition, the Liebermann–Burchard reacting neutral sterols of the fæces were measured by the method of Abell *et al.*[5] and total fæcal lipid according to van de Kamer *et al.*[6]. The serum cholesterol was also measured by the method of Abell *et al.*[5].

For 12 days, four subjects were fed a basal diet containing 8 gm. of fat and 2,000 calories. Then, in the first pair of subjects, 100 gm. of hydrogenated coconut fat (iodine number 6) was introduced into the diet by isocaloric substitution; after 12–15 days,

Table 1. The Effects of feeding Hydrogenated Coconut Fat and Sunflower Seed Oil Separately. Mean Figures are Given for the Four Subjects, although the Order of Feeding of the Fat and the Oil was Reversed in Paired Subjects (see Text)

| | Basal period 8 gm. of fat/24 hr. (12 days) | Hydrogenated coconut fat 100 gm./24 hr. (12–15 days) | Sunflower seed oil 100 gm./24 hr. (12–15 days) |
|---|---|---|---|
| Serum cholesterol (mgm. per cent)* | 119 | 168 | 93 |
| Fæcal lipid (gm./24 hr.) | 1·8 | 5·7 | 7·2 |
| Fæcal neutral sterols (mgm./24 hr.) | 390 | 680 | 880 |
| Fæcal bile acids (mgm./24 hr.) | 142 | 127 | 258 |

* The basal figure is the mean of four readings per subject; all other figures are of the serum cholesterol at the end of each feeding period.

this was replaced by 100 gm. of sunflower seed oil (iodine number 135) for a similar period. In the other two subjects, the dietary fats were administered in the reverse order. The results are summarized in Table 1.

A second investigation was conducted on a further three subjects. After 10 days on a basal diet of 2,500 calories and 8·25 gm. of fat, 75 gm. of hydrogenated coconut fat was added to the diet. After 10 days, the diet was further supplemented by 75 gm. of sunflower seed oil, and this was continued for 20 days. Finally, the sunflower seed oil was withdrawn, and for the last 10 days only the hydrogenated coconut fat supplement was fed. The results are summarized in Table 2.

In all seven subjects, when hydrogenated coconut fat was fed alone, the serum cholesterol rose. When sunflower seed oil was fed before, in addition to, or after the fat, there was a fall in the serum cholesterol level. Administration of either fat produced an increase in total fæcal lipid. This was somewhat more marked with sunflower seed oil than with the hydrogenated coconut fat, but at all times the absorption of dietary lipid was more than 93 per cent. The fæcal neutral sterols also were increased when hydrogenated coconut fat was fed and were further increased by sunflower seed oil. This may partly reflect the relative content of Liebermann–Burchard reacting sterols in the two fats (303 mgm. per cent in hydrogenated coconut fat and 751 mgm. per cent in sunflower seed oil). Of particular interest were the changes in fæcal bile-acid excretion; there was virtually no change from basal level when hydrogenated coconut fat was fed alone; with the introduction of sunflower seed oil, both by addition and substitution, fæcal bile-acid excretion almost doubled.

Table 2. The Effects of Feeding Hydrogenated Coconut Fat Alone and Together with Sunflower Seed Oil. Mean Results in Three Subjects

| | Basal period 8·25 gm. of fat/24 hr. (10 days) | First hydrogenated coconut fat period 75 gm./24 hr. (10 days) | Hydrogenated coconut fat 75 gm./24 hr. + sunflower oil 75 gm./24 hr. (20 days) | Second hydrogenated coconut fat period 75 gm./24 hr. (10 days) |
|---|---|---|---|---|
| Serum cholesterol (mgm. per cent)* | 113 | 152 | 136 | 161 |
| Fæcal lipid (gm./24 hr.) | 2·7 | 4·1 | 6·7 | 4·2 |
| Fæcal neutral sterols (mgm./24 hr.) | 663 | 843 | 993 | 766 |
| Fæcal bile acids (mgm /24 hr.) | 128 | 158 | 333 | 136 |

* The basal figure is the mean of three readings per subject; all other figures are of the serum cholesterol at the end of each feeding period.

In these experiments, therefore, the fall in serum cholesterol-level induced by sunflower seed oil has been associated with an increase in bile-acid excretion. These preliminary data are consistent with the tentative hypothesis that in exerting its effect on the serum cholesterol, sunflower seed oil promotes the catabolism of this sterol and its excretion from the body.

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## A New Type of Carcinostatic Agent

There are various ways of approaching the cancer problem. One way is to attempt to find substances which will prevent mitosis. For if cancer is due to uncontrolled cell division, the inhibition of cell division by relatively harmless substances would be a means of combating the disease. For some years it has been argued that the initiation of cell division is due to a clotting reaction in the protoplasmic colloid, a reaction that leads to the formation of the mitotic spindle, and it has been urged that anti-clotting agents can successfully inhibit cell division. The evidence for this point of view has been summarized in a recent monograph[1]. Heparin can prevent cell division, but for one reason or another it is not a highly successful agent in retarding the growth of a tumour. Extracts of ovaries are more potent antimitotic agents[2], and indeed such extracts obtained from the ovaries of various invertebrates, from the ovaries of many fishes, and from the ovaries of amphibians and mammals can keep protoplasm fluid and thus prevent the mitotic gelation which is a necessary precursor of the division of the cell.

For several years we have prepared extracts from cow ovaries in the hope that such extracts would prove to have carcinostatic activity. Our early experiments gave somewhat variable results, and sometimes indeed the extracts we prepared hastened, rather than prevented, the death of animals with implanted tumours. For that reason we tried in various ways to purify our crude extracts so that they would be more potent both as antimitotic agents and as carcinostatic agents.

For a long time we were unsuccessful, and in the somewhat purer preparations we obtained by a number of standard procedures, both the antimitotic and

carcinostatic action were lost. Then about a year ago, we tried fractional precipitation of our crude extracts in the cold with various concentrations of alcohol. A fraction obtained with an intermediate concentration of alcohol (45–60 per cent) retained antimitotic potency. This fraction, though soluble with difficulty in sea water, had a clear-cut antimitotic action on eggs of the worm *Chaetopterus*, and studies of protoplasmic viscosity showed that, in the eggs exposed to dilute solutions of this fraction, the mitotic gelation was completely inhibited. Also this fraction when dissolved in sea water prevented cell division in eggs of the clam *Spisula*.

During the past year we have experimented with more than four thousand mice, all implanted with Ehrlich ascites tumours. Among the control, untreated mice, only 1 per cent of the animals survived, and these in so far as we could determine were cases in which proper inoculation had not been made. On the other hand, precipitates obtained with intermediate concentrations of alcohol were potent carcinostatic agents for the very lethal type of tumour that we were using. In one instance, an extract had no activity but other extracts were effective, and 15–25 per cent of the mice treated with saline solutions containing the fractions obtained with intermediate concentrations of alcohol survived indefinitely.

Details of our experiments will be presented elsewhere. Thus we expect to publish the first of a series of papers in the immediate future[3]. Since this paper was written, changes in our methods of extraction and purification have yielded even more impressive results with higher percentages of survival than those noted above. These later experiments are now being repeated, and will be reported as soon as we know more about them.

The work reported here in preliminary fashion was supported by grants from the American Cancer Society, the National Cancer Institute and the National Science Foundation.

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## Innervation of the Lamellibranch Muscle

Little seems to be known regarding the innervation of the lamellibranch muscles, especially of the adductors. J. Bowden and J. Lowy[1] found nerve fibres and nerve endings in the muscles (Ranvier's gold chloride method), but as they state: "the results were never really satisfactory". They found methylene blue staining adequate to detect the larger trunks and to trace their course, but the process, by their own admission, is "useless for showing details of innervation". As to other methods of impregnation used, Bowden and Lowy state: "no nerve elements could be stained" in this region.

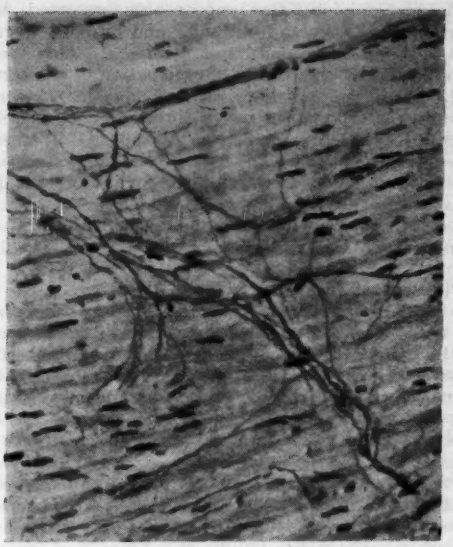

Fig. 1. *Unio* adductor. Nerve-plexus. Bielschowsky–Abrahám method (× 120)

We have succeeded in revealing the innervation, even down to details, of the adductors of *Unio* and *Anodonta*.

The nervous system of muscles of these lamellibranchs can be detected by Abrahám's modification of Bielschowsky's method[2]. By means of this modification, not only the small and large trunks, branches and plexuses are shown up, but also the close connexion of the single nerve fibres with the muscle fibres can be fairly well demonstrated. Within the plexuses there is neither anastomosis nor reticulum[3]; in the end plexuses the single fibres are independent, with no terminal reticulum (Fig. 1).

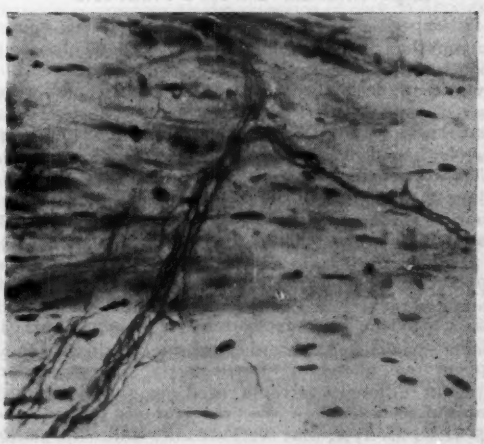

Fig. 2. *Unio* adductor. Nerve-plexus. Thick and thin nerve fibres. Bielschowsky–Abrahám method. (× 120)

In our opinion, the appearances reported by Bowden and Lowy as multipolar and unipolar nerve cells are not nerve cells, but artefacts. This view is supported by the results of extirpation of the cerebral and visceral ganglions respectively; it is stated that after 60–70 hr., the nerve fibres of the adductors begin to degenerate and later disappear. If there were nerve cells in the adductors, only partial degeneration could occur, since removal of the ganglions would leave the assumed nerve cells and processes intact. Our photomicrographs show that there is no 'intrinsic' nervous system in the adductors.

Plexuses of different size and density consist of two kinds of fibres (Fig. 2). Both are richly branched, but without anastomosis. The extremely fine branches can be followed for a good distance, but they gradually become thinner and disappear without any special formations, as reported by A. Brück[4], and by Bowden and Lowy[1]. Quite fine granules or knobs can be observed at the ends of certain fibres with high-power magnification.

Statements that the nerve fibres run parallel to the longitudinal axis of the muscle fibres are based on erroneous observations. We find that, with a few exceptions, the nerve trunks and branches form an angle with the longitudinal axis of the muscle fibres; in our opinion the parallel fibres reported by Bowden and Lowy are not nerve fibres.

The myristoylcholine method of G. B. Koelle[5] is not suitable for demonstrating the innervation of lamellibranch muscles. The results of our investigations will be published in detail elsewhere.

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[1] Bowden, J., and Lowy, J., *Nature*, **176**, 346 (1955).
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## A Lipid Material in Bone and Teeth in Experimental Chronic Fluorosis

In experimental chronic fluorosis and in spontaneous fluorosis in man[1], many authors have observed peculiar dark blue granules in paraffin and celloidin sections of decalcified bone and teeth stained with hæmatoxylin-eosin (Fig. 1). It has been suggested that these could be either calcium fluoride[2,3] or merely a pathological calcification[4,5]. Examination of powdered material[6] from bone and teeth (rat), using X-ray diffraction, failed to detect any calcium fluoride. (The method used permitted detection of 0·5 per cent or more calcium fluoride in bone powder.)

Histochemical tests have shown that the granules appear periodic acid–Schiff positive. They do not stain metachromatically with toluidine blue, and the methylene blue extinction occurs about pH 3. Using phase-contrast microscopy (positive) they appear as glistening particles. Various sudan dyes in different solvents used on the decalcified paraffin sections show that the granules do not take up the red dyes, but very readily take up sudan black *B* dissolved in 70 per cent ethyl alcohol. After extraction with pyridine, there is no uptake of sudan black *B* though the outline of the extracted granules is still visible.

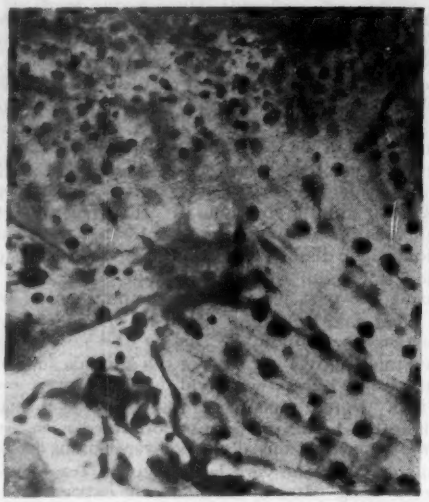

Fig. 1. Granules in terminal plate of epiphysis from rat femur. Decalcified paraffin section. Hæmatoxylin-eosin (× c. 260)

It is therefore suggested that the granules seen in decalcified paraffin sections consist mainly of a lipid material.

Further investigations using histochemical and X-ray diffraction methods are in progress.

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[1] Roholm, K., "Fluorine Intoxication" (thesis), 186, 191 (1937).
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## Colour Vision of Achromats' Parents

Two achromats, a woman student and a man student, were recently tested for colour vision. Both proved to be of the so-called pure rod-vision type[1], completely lacking in hue discrimination, with marked photophobia, nystagmus and central scotoma in photopic vision, and both had been totally colour blind since infancy.

Since there is evidence that red–green colour vision major defects often have heterozygous manifestations[2], we tested the parents of these achromats with the anomaloscope. Tables 1 and 2 summarize the

Table 1. The Achromats' Fathers

| | Red–green test | Yellow–blue test |
|---|---|---|
| Man's father (age 62) | Green deviation: frequency, 13/209 men<br>Matching range: frequency, 24/209 men | Deviation not abnormal<br>Matching range normal |
| Woman's father (age 58) | Green deviation: frequency, 43/209 men<br>Matching range: frequency, 14/209 men | Deviation not abnormal<br>Matching range: frequency, 24/209 men |

Table 2. The Achromats' Mothers

| | Red–green test | Yellow–blue test |
|---|---|---|
| Man's mother (age 58) | Deviation not abnormal<br>Matching range: normal | Deviation not abnormal<br>Matching range: frequency, 8/213 women |
| Woman's mother (age 58) | Red deviation: frequency, 18/231 women<br>Matching range: frequency, 9/213 women | Deviation not abnormal<br>Matching range: frequency, 8/213 women |

results, comparing the frequencies of the parent's abnormalities with those found in a standard population[3].

It will be seen that both fathers had abnormal green deviations and red–green matching ranges, but that the enlarged matching range of the woman's father was their only yellow–blue defect, although their ages were 62 and 58.

The woman achromatope's mother had an abnormal red deviation and red–green matching range, but the man's mother was normal in red and green. The mothers had no abnormal yellow–blue deviations, although both their ages were 58, but each had an abnormal yellow–blue matching range.

Although only four parents of achromats were tested, a number of infrequent differences from the normal were found, and these results suggest that tests on a larger number of the near relatives of achromats might confirm the suspicion that this defect has a tendency towards heterozygous manifestation. Both achromats were only children.

Thanks are due to the achromatopes (Miss Gwen Jones and Mr. Colin B. Blakemore) and to Dr. Peter McKellar (of Sheffield) and Mr. George Westby (of Hull).

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[2] Sloan, Louise L., *J. Opt. Soc. Amer.*, **44**, 117 (1954); Geldard, F. A., *J. Opt. Soc. Amer.*, **23**, 256 (1933).
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## Tactic Movements in *Chlamydomonas moewussi*

Species of *Chlamydomonas* are generally regarded as phototactic[1]. For a study of certain aspects of phototaxis, *Chlamydomonas moewussii* (Pringsheim collection 11–16 *g*) was cultivated on a medium described by Hutner and Provasoli[2]. The algae in their culture medium were placed in cuvettes which were illuminated from the side. Under these conditions, phototactic algae move rapidly to the illuminated side of the cuvette. The species studied showed no such phototaxis, but invariably moved to the water–gas interface. If the cuvettes were covered with olive oil, the algae moved through the oil layer to the interface. The gas phase was therefore altered. Square glass cuvettes (v. 35 ml.) were filled with 15 ml. algal suspension and fitted with rubber stoppers with in and outlet tubes. The gas phase (20 ml.) of each cuvette was flushed with 2 litres of gas mixture and the cuvettes then closed. The cuvettes were then placed under conditions of unilateral illumination. In parallel experiments, algae of the same age and culture were used. Table 1 summarizes the results of the different treatments.

Table 1. Effect of Flushing Gas Phase with Various Mixtures and Observing Behaviour of Algae after 24 hr. in Closed System

| Gas phase / Illumination | Air | Nitrogen | Air + 50 per cent $CO_2$ | Air + 75 per cent $CO_2$ | 100 per cent $CO_2$ | Gas and liquid flushed with $CO_2$-free air |
|---|---|---|---|---|---|---|
| 300 ft.-candles | ++ | + | ++ | ++ | ++ | − |
| 1,000 ,, | ++ | + | ++ | − | − | − |

++, strong tactic movement to water–gas interphase.
+, slight tactic movement to water–gas interphase.
−, settling out.

When the gas phase was flushed with nitrogen, the tactic movement became less marked, but still existed. When the gas phase was swept out with carbon dioxide-free air and in addition the stream was bubbled vigorously through the solution for some time, there was complete settling out of the algae, when the algae were left in the closed cuvettes.

Flushing the gas phase with air containing various amounts of carbon dioxide led to unexpected results. At concentrations up to 50 per cent carbon dioxide, there was marked taxis towards the air–water interface at all light intensities. With more than 50 per cent carbon dioxide, however, at 75 per cent and 100 per cent, the algae settled out when exposed to light intensities of 1,000 ft.-candles and more. When the algae were exposed at the same concentration of carbon dioxide to 300 ft. candles, there was no settling. Moreover, transfer of algae exposed to 300 ft.-candles and 100 per cent carbon dioxide for one day to 1,000 ft.-candles did not cause subsequent settling. In all cases when there was settling out, the algae recovered if re-exposed to air after 24 hr. This recovery was characterized by redistribution of the algae throughout the medium with some concentration at the water–air interface. Apparently, recovery of lost motility is involved in this process.

The lack of taxis when all carbon dioxide is swept out from gas and medium, and the decreased taxis when carbon dioxide is removed from the gas phase but not from the medium, points to the correlation of tactic movement to the presence of carbon dioxide. It appears that the *Chlamydomonas* species studied shows taxis towards carbon dioxide.

The reason for the difference in behaviour at different light intensities is not clear. *p*H cannot have been a factor, as the conditions were identical for the two light treatments. However, the temperature at 1,000 ft.-candles was higher than that at 300 ft.-candles. Air controls showed no settling, nor did the lower concentration of carbon dioxide. It is possible that the settling out effect was a combination of higher concentration of carbon dioxide and raised temperatures.

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## Polyhedral Shape of Adenovirus Particles as shown by Electron Microscopy

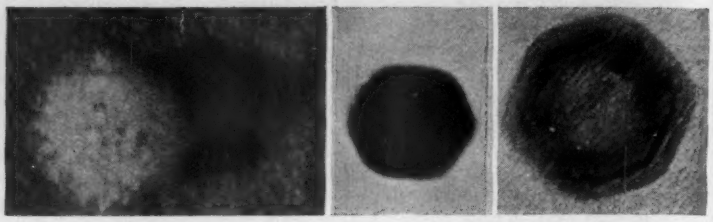
Crick and Watson[1] suggested that a small virus particle contains identical protein sub-units packed together with cubic symmetry, and they went on to predict from this that the virus particle itself might be polyhedral. Electron micrographs have since shown that various viruses do give hexagonal images. This is clearly the case, for example, for the plant virus of turnip yellow mosaic[2] and for an insect virus that infects the larvæ of the crane fly[3]. We now report finding a similar hexagonal shape for the particles of adenovirus which is a human pathogen.

Suspensions of this virus were prepared from large pools of HeLa cell cultures of high infectivity and were concentrated by differential centrifugation. The virus particles when fixed with osmium tetroxide and metal-shadowed (Fig. 1,*a*) gave images which did not clearly differ from those of spherical objects apart from a suggestive angularity in the shadows. Similarly, the virus particles in sections of infected HeLa cells shown in the excellent electron micrographs of Morgan, Howe, Rose and Moore[4] were described as round. On the other hand, Brandon *et al.*[5] have reported that the images of some of the particles found in their suspensions appeared to be five-sided. When we increased the electron density of the osmium tetroxide fixed virus particles by treating them further with 1 per cent phosphotungstic acid, it was seen that in fact the particles have a clearly hexagonal image (Fig. 1,*b*). This appearance was confirmed by making carbon replicas of the surface of formalin fixed particles (Fig. 1,*c*) using the method of Bradley[6]. In this latter procedure the particles themselves were removed from the replica with concentrated sodium hydroxide.

As judged from the electron micrographs of phosphotungstic acid treated preparations, the virus particles have a uniform size of about 700 A. and each gives a similar six-sided image however it happens to be orientated on the supporting film. We therefore assume that the particles have a symmetrical polyhedral form. Of the possible shapes, only two are consistent with the hexagonal appearances seen in our electron micrographs, the rhombic dodecahedron (a solid with twelve identical rhombic faces) and the icosahedron (twenty faces, each an equilateral triangle).

By metal-shadowing the phosphotungstic acid treated preparations, it was possible to obtain clear shadows without masking the hexagonal outline of the virus; the shadows varied from pointed to flat-topped, depending on the orientation of the particles. Models of the rhombic dodecahedron and the icosahedron were then used in an attempt to identify the shape consistent with these appearances, but it was found that neither model threw a shadow so characteristic that it could not be closely matched by a suitable orientation of the other. Thus it was not possible to draw a precise conclusion from the metal-shadowed preparations as to the exact shape of the virus. So far, replicas have also failed to show unequivocally whether the faces are rhombic or triangular.

The regular shape of the particles is allied to a remarkable resistance to attack with proteolytic enzymes (trypsin, pepsin and papain) and both nucleases, procedures that almost entirely digest vaccinia[7], influenza and similar viruses[8,9].



*a* *b* *c*

Fig. 1. Electron micrographs of adenovirus particles (type 6) from infected HeLa cell cultures. *a*, a particle shadowed with platinum (× 280,000); *b*, a particle treated with phosphotungstic acid (× 250,000); *c*, a particle replicated with carbon (× 280,000)

Technical assistance with the electron microscopy was given by Mr. O. Green and Miss Janet Lawrence.

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July 16.

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## The Polyhedral Virus of *Heliothis armigera* (Hbn.)

With reference to the communication by Dr. G. H. Bergold and Dr. W. E. Ripper on the polyhedral virus of *Heliothis armigera*[1], it has evidently escaped their notice that the virus of this nuclear polyhedral disease has already been isolated and characterized on the electron microscope. Furthermore, experiments in the use of this virus in the control of the American cotton bollworm in Uganda are now actively in progress in collaboration with Mr. T. H. Coaker, of the Empire Cotton Growing Corporation[2].

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Virus Research Unit,
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# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, November 4

FARADAY SOCIETY (in the Main Lecture Theatre, Chemistry Department, Imperial College, London, S.W.7), at 5 p.m.—Prof. W. Jost (University of Göttingen): "Crystal Defects, Especially Near Phase Transitions"* (Bourke Lecture).

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Dr. S. Livingston Smith and Dr. J. E. Richards: "Nuclear Power for the Propulsion of Merchant Ships".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the FOOD GROUP, at 14 Belgrave Square, London, S.W.1), at 6.15 p.m.—Dr. J. R. Nicholls, Dr. J. Williams, Mr. R. D. Mason and Dr. F. H. Banfield: "Technological and Analytical Problems involved in the Use of Food Additives".

## Tuesday, November 5

UNIVERSITY COLLEGE, LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. A. French: "The Changing Landscape of the Soviet Union".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. R. P. Linstead, C.B.E., F.R.S.: "An Education for Our Times?" (Ninth Hinchley Memorial Lecture).

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, London, S.W.1), at 5.30 p.m.—Sir Arthur Whitaker: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENT AND CONTROL SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W.1), at 6.30 p.m.—Dr. Rudolf Pribil (Czechoslovak Academy of Sciences): "Recent Developments in Chelatometry".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. C. H. Bamford: "Synthetic Polypeptides as Protein Models".

## Wednesday, November 6

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. E. A. Jobbins: "Colour and Geology"; Mr. B. W. Anderson: "Gems".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. G. Chandler and Mr. D. W. Lindsell: "Cyclical Fluctuations and Black Oil Demand—an Introduction".

WOMEN'S ENGINEERING SOCIETY, LONDON BRANCH (at the Central Electricity Authority Headquarters, Winsley Street, London, W.1) at 6.45 p.m.—Mr. D. W. S. Limbert: "Meteorological Aspects of the International Geophysical Year".

## Thursday, November 7

CHEMICAL SOCIETY (joint meeting with the FINE CHEMICALS GROUP of the SOCIETY OF CHEMICAL INDUSTRY, in the Large Chemistry Lecture Theatre, University College, Gower Street, London, W.C.1), at 2.15 p.m.—Symposium on "Newer Preparative Methods in Organic Chemistry".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. Wilson Smith, F.R.S.: "Virus-Host Cell Interactions" (The Leeuwenhoek Lecture).

BONE AND TOOTH SOCIETY (at the Institute of Orthopædics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Sulphate Metabolism in Bone and Connective Tissue". Dr. S. R. Pelc: "Sulphate Metabolism in Cartilage as Indicated by Autoradiographs"; Dr. E. Kodicek: "Vitamin C and Sulphate Metabolism of Connective Tissue Mucopolysaccharides"; Dr. R. C. Curran: "Sites of Formation of Sulphated Mucopolysaccharides in Connective Tissues".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. A. Bogdan: "Flowering Habits of Rhodes Grass"; Prof. Tom Harris, F.R.S.: "A Burnt Mesozoic Flora of South Wales"; Major J. P. T. Burchell: "The Sub-aerial Loams of Post-glacial Times and their Molluscan Content as Evidenced in Kent".

INSTITUTE OF REFRIGERATION (at the Junior Institution of Engineers, Pepys House, 14 Rochester Row, Westminster, London, S.W.1), at 5.30 p.m.—Dr. W. Summer: "A Review of Methods for Odour Control in Refrigerated Space".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion of the Report on "The Supply and Training of Teachers for Technical Colleges".

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. H. Lehmann: "Variations in Hæmoglobin Synthesis".* (Seventh of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation. Further lectures on November 12, 14, 19, 21, 26, 28 and December 3 and 5.)

INSTITUTE OF PHYSICS, STRESS ANALYSIS GROUP (in the Department of Civil and Municipal Engineering, University College, Gower Street, London, W.C.1), at 6 p.m.—Discussion on "Photoelastic Reflection Techniques" introduced by Dr. H. Fessler and Mr. D. J. Haines.

INSTITUTE OF METALS, LONDON LOCAL SECTION (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Dr. J. White: "Refractories".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the BRUNEL COLLEGE OF TECHNOLOGY SCIENTIFIC SOCIETY, at the Brunel College of Technology, Woodlands Avenue, Acton, London, W.3), at 7 p.m.—Dr. R. Spence: "Some New Instruments Developed at Harwell".

## Thursday, November 7—Friday, November 8

NATIONAL ASSOCIATION FOR MENTAL HEALTH (at the Central Hall, Oldham Street, Manchester).—Conference on "The Challenge of Mental Deficiency".

## Friday, November 8

BRITISH GLACIOLOGICAL SOCIETY (in Lecture Room 4, The University, Edgbaston, Birmingham), at 5 p.m.—Mr. R. G. West: "The Glacial Period in East Anglia".

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE, at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. H. Kronberger: "Vacuum Techniques in the Atomic Energy Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Geoffrey Gee, F.R.S.: "New Ways with Large Molecules".

## Saturday, November 9

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Miss Christina Hole: "Witchcraft in England".*

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN CHEMISTRY; ASSISTANT LECTURER IN PHYSICS; ASSISTANT LECTURER IN BOTANY; ASSISTANT LECTURER IN ZOOLOGY; a LABORATORY TECHNICIAN IN CHEMISTRY; and a LABORATORY TECHNICIAN IN BOTANY AND ZOOLOGY, in the Faculty of Science, National University of Libya, Tripoli—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "N.4 (57)" (November 8).

READER IN PHYSICAL METALLURGY; a READER IN INDUSTRIAL METALLURGY; and a READER IN ELECTRICAL ENGINEERING (HEAVY CURRENT)—The Registrar, College of Technology, Suffolk Street, Birmingham (November 11).

SHELL B.P. RESEARCH FELLOW IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING—The Secretary and Registrar, The University, Southampton (November 11).

LECTURER OR ASSISTANT LECTURER IN PSYCHOLOGY—The Registrar, The University, Hull (November 15).

LECTURER (with an honours degree in zoology) IN THE DEPARTMENT OF ZOOLOGY, Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, November 15).

ELECTRICAL ENGINEER/PHYSICIST IN THE DEPARTMENT OF PHYSICS, to supervise the operation of a 6-MeV. van de Graaf machine, and to develop associated research equipment—Prof. Samuel Devons, The Physical Laboratories, The University, Manchester 13 (November 16).

ASSISTANT LIBRARIAN—The Secretary, The University, Aberdeen (November 19).

LECTURER (Grade II) IN GEOCHEMISTRY within the Department of Geology—The Registrar, The University, Bristol (November 20).

SENIOR LECTURER OR LECTURER IN PHILOSOPHY at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 20).

READER (academically qualified and able to promote research and conduct postgraduate lecture courses) IN CONTROL ENGINEERING—The Clerk to the Governing Body, Battersea College of Technology, London, S.W.11 (November 22).

ASSISTANT LECTURER (preferably with a special interest in inorganic chemistry) IN CHEMISTRY—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1 (November 23).

INORGANIC CHEMIST, Scientific Officer/Senior Scientific Officer grade (with a first- or second-class honours degree in chemistry, or equivalent), at the National Physical Laboratory (Metallurgy Division), Teddington, Middlesex, for work which includes the investigation of new techniques, including mass spectrometry and activation analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.243/7A (November 23).

HARRISON CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Liverpool (November 30).

RESEARCH ASSISTANT (with an honours degree in biochemistry or pharmacology) IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS, to work on the effect of hypoglycæmic drugs on carbohydrate metabolism—The Department of Medicine, Queen's College (University of St. Andrews), Dundee (November 30).

SCIENTIFIC OFFICER (with an honours degree in zoology (or botany, plant pathology), IN THE NEMATOLOGY DEPARTMENT, for field and laboratory work on pea root eelworm—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (November 30).

LECTURER IN PHYSICAL CHEMISTRY OR INORGANIC CHEMISTRY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 6).

SENIOR LECTURER (preferably with qualifications in the general field of modern algebra or topology) IN MATHEMATICS at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, December 16).

CHAIR OF EXPERIMENTAL PATHOLOGY in the John Curtin School of Medical Research, Australian National University, Canberra—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1.

CONTROL OFFICER (preferably single, with a good general education and agricultural training or knowledge of surveying, mapping, entomology or botany) IN THE NORTHERN NIGERIA GOVERNMENT Medical Department—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.34/43728/NF.

ENTOMOLOGIST (with a good honours degree and a keen interest in applied entomology), to develop and apply laboratory techniques for investigating the biological activity of insecticides and spray deposits—The Secretary, East Malling Research Station, near Maidstone, Kent.

LECTURER IN INORGANIC CHEMISTRY for higher national certificate and Grad.R.I.C. courses, at Coventry Technical College—The Director of Education, New Council Offices, Coventry.

LECTURER (with a special interest in applied chemistry) IN THE CHEMISTRY DEPARTMENT; and a SENIOR LECTURER, LECTURER, and ASSISTANT (Grade B) IN THE PHYSICS DEPARTMENT—The Principal, Royal Technical College, Salford.

LECTURER (with special qualifications in inorganic chemistry and/or physical chemistry) IN CHEMISTRY—The Secretary, Royal College of Science and Technology, Glasgow.

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SENIOR RESEARCH ASSISTANT (with postgraduate experience in the mechanics of solids, particularly elasticity) IN THE DEPARTMENT OF MINING ENGINEERING, to work on the theoretical analysis of ground movements in mining, under the supervision of the Professor of Applied Mathematics—The Registrar, The University, Nottingham.

STATISTICIAN (with a good honours degree in mathematics or statistics), for biometrical research and consultation in the Section of Statistics—The Secretary, National Institute for Research in Dairying (University of Reading), Shinfield, Reading, quoting Ref. 57/9.

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